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THE ELECTRICAL EQUIPMENT OF A LARGE HOSPITAL.

LIGHTING AND POWER PLANT OF THE LYING-IN HOSPITAL, NEW YORK.

BY CHARLES E. KNOX.

The new maternity hospital located on the west side of Second Avenue and extending from 17th to 18th Street, New York City, has been provided with an electric plant of the most modern design and equipment. The building is of the usual fireproof construction, having steel columns and beams, except that in place of terra cotta, the Roebling form of construction was used for both the floor arches and the partition walls. The flooring consists of a patent compound called "Lignolith," consisting of a mixture of sawdust and the salts of magnesia. This mixture was made at the building and was put down on the floor in a manner somewhat similar to the way concrete is laid. The flooring was in all cases extended up in a curve around the sides of the room to form a base board, thus avoiding angles or cracks at the junction of the floor and the baseboard which might serve as a dust trap, which would be very objectionable in a hospital building.

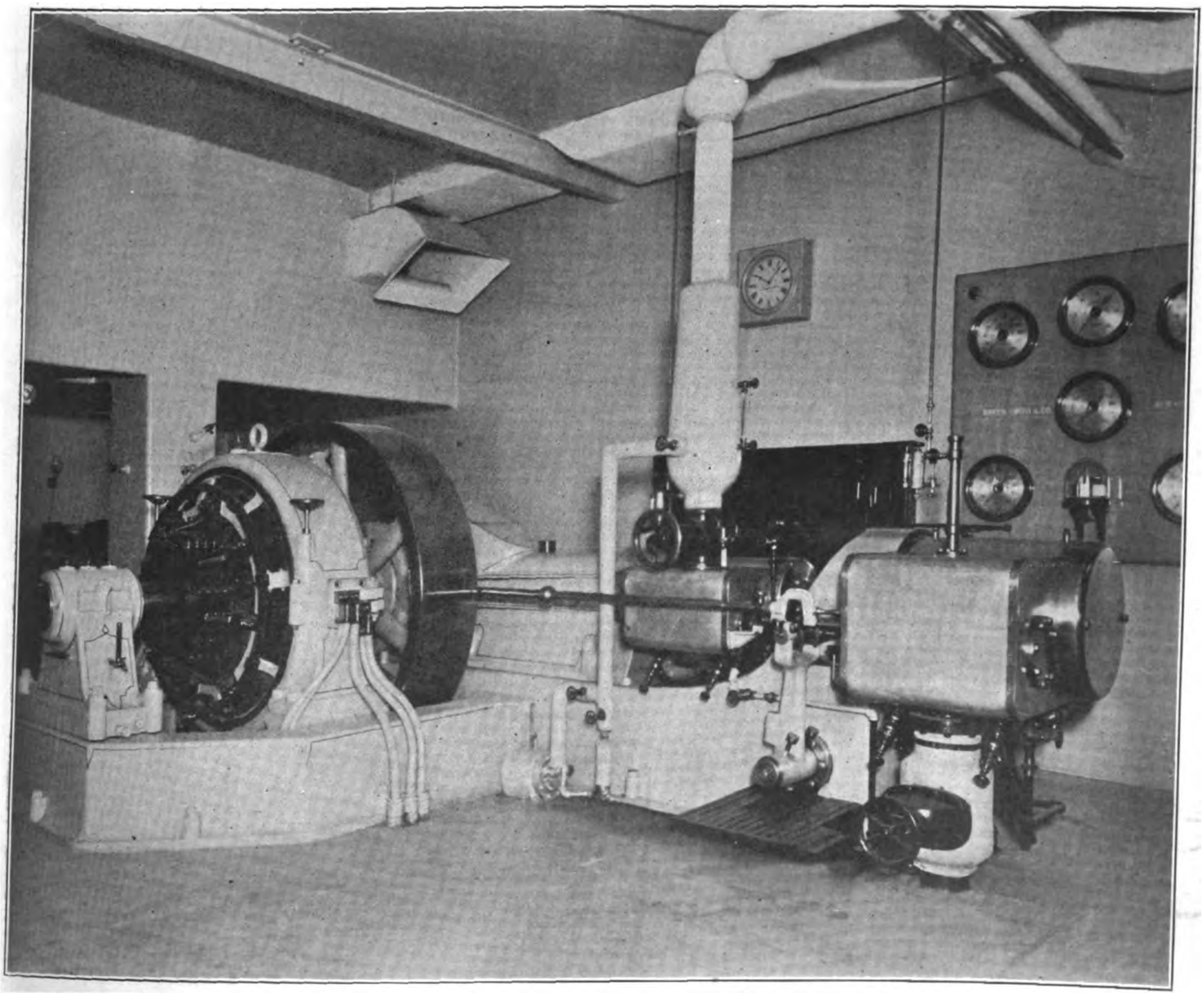

FIG. I.—ONE OF THE GENERATING SETS IN THE ENGINE ROOM.

The particular purpose for which the building is to be used caused certain departures from the ordinary practice in the electrical work, as well as in the building construction. As a matter of antiseptic precaution, angles or corners were avoid-

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ed wherever possible; all boxes, cabinets, etc., were made and installed so as to be flush with the walls, ceilings, etc. In fact, every possible effort was made to prevent the elusive microbe from finding a convenient abiding or breeding place. Special precautions were even taken in the arrangement of the conduits for the electric wiring, to prevent the little "beasts" from passing through them from one room to another; this will be described in detail further along.

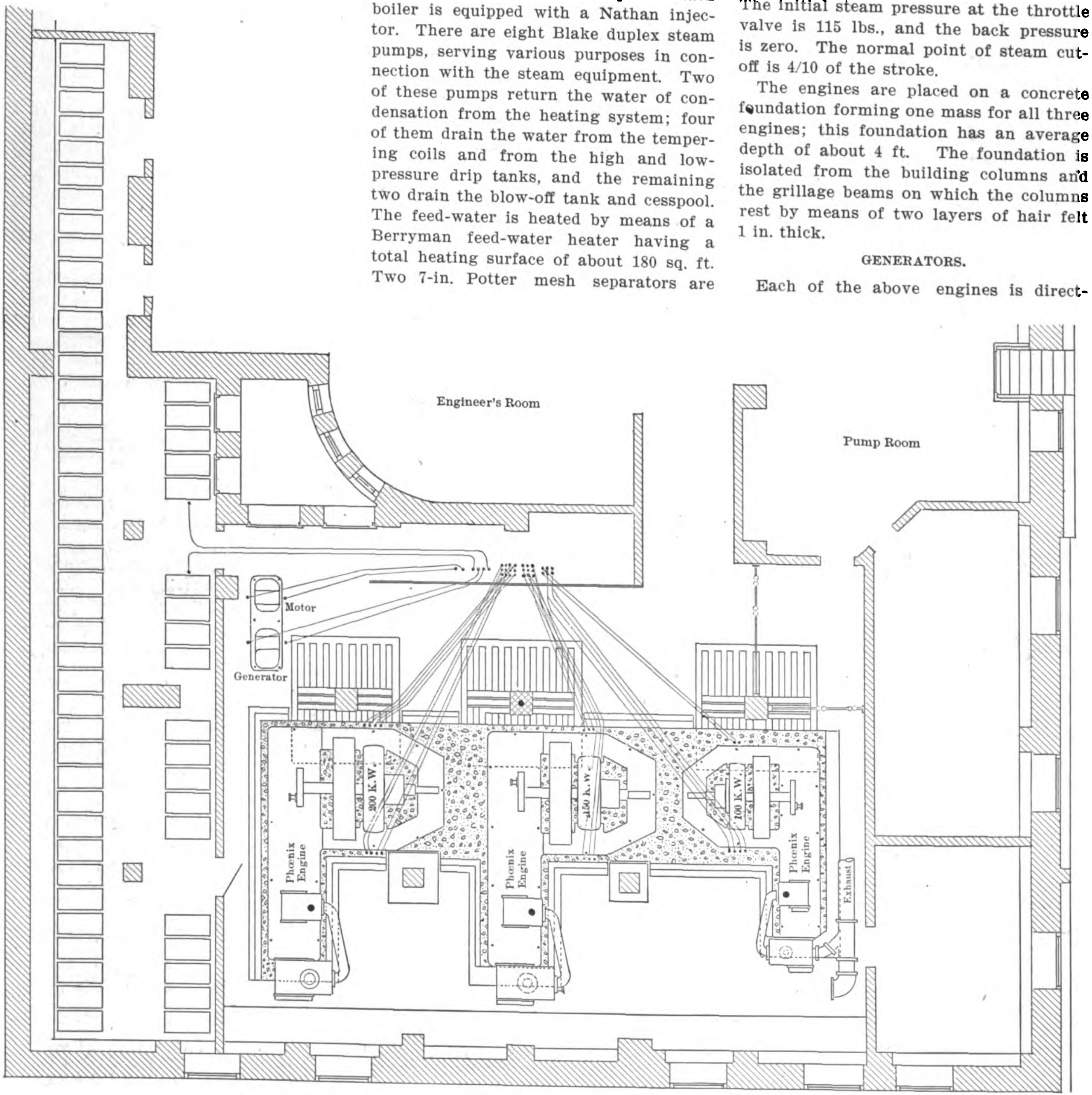


FIG. 2.—PLAN SHOWING ARRANGEMENT OF GENERATOR EQUIPMENT AND STORAGE BATTERIES.

The electric generating plant has a total capacity of 450 kilowatts, a 10-kw. motor-driven booster and a 2500-ampere-hour (about 300 kilowatt-hours) storage battery; the plant affords service supply for 3200 16-c.p. lamps, four electric elevators, three dumb-waiters and one ash lift; 14 fans for ventilating purposes; one pump motor; and for charging the storage battery of an automobile ambulance.

STEAM PLANT.

The boilers for supplying the generating plant, heating, etc., are located in the cellar under the sidewalk on Second Avenue. They are three in number, in two batteries, and have a total nominal capacity of about 650 horse-power. The total number of square feet of heating surface is about 6500 sq. ft.; the total grate surface is about 150 sq. ft. Each boiler is equipped with a Nathan injector. There are eight Blake duplex steam pumps, serving various purposes in connection with the steam equipment. Two of these pumps return the water of condensation from the heating system; four of them drain the water from the tempering coils and from the high and low-pressure drip tanks, and the remaining two drain the blow-off tank and cesspool. The feed-water is heated by means of a Berryman feed-water heater having a total heating surface of about 180 sq. ft. Two 7-in. Potter mesh separators are placed in the drum of each of the three boilers. In addition to these a De Rycke steam separator is placed in each of the branches supplying steam to the three engines.

The engine room is located in the cellar at the 17th Street end of the building. Figs. 1 and 2 show a plan and elevation of the engine and storage battery rooms. There are three engines, of the tandem-compound horizontal side-crank type. They are of the Dick and Church design and were built by the Phoenix Iron Works. The various data relating to the three engines are given in the table below.

I.H.P. of engine.	Diam. of cylinders.	Stroke.	Speed, r.p.m.	Total Weight.
320	15½ and 27 ins.	18 ins.	200	50,000
240	13¾ and 24 ins.	18 ins.	200	47,500
160	11 and 20 ins.	15 ins.	230	27,000

The initial steam pressure at the throttle valve is 115 lbs., and the back pressure is zero. The normal point of steam cut-off is 4/10 of the stroke.

The engines are placed on a concrete foundation forming one mass for all three engines; this foundation has an average depth of about 4 ft. The foundation is isolated from the building columns and the grillage beams on which the columns rest by means of two layers of hair felt 1 in. thick.

GENERATORS.

Each of the above engines is direct-connected to a direct-current, 116-volt, compound-wound Westinghouse dynamo of the ordinary multipolar type. The sizes of the three generators are 200 kilowatts, 150 kilowatts and 100 kilowatts, the normal load current being 1696 amperes, 1272 amperes and 848 amperes, respective-

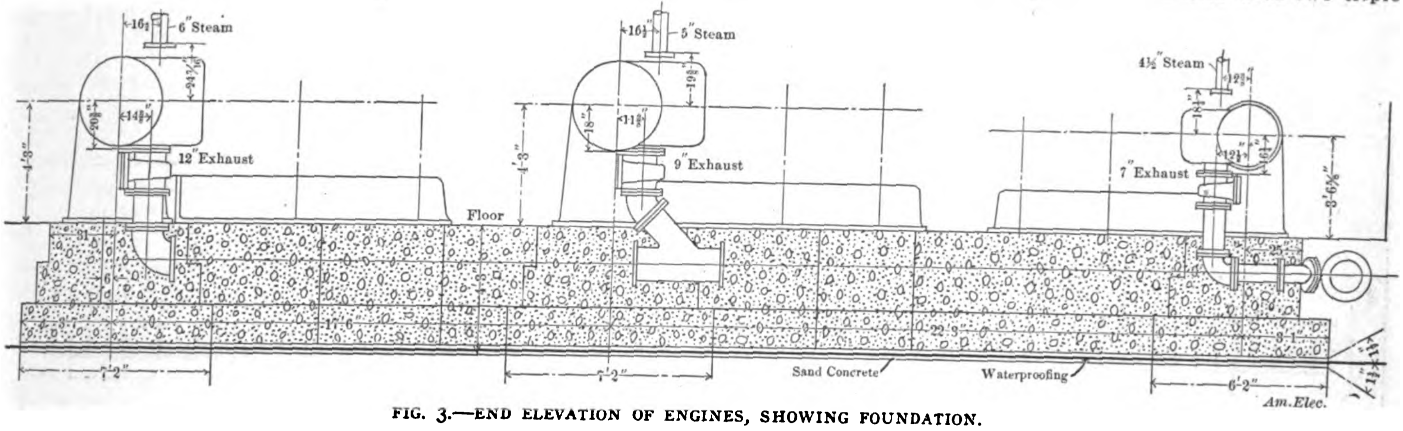


FIG. 3.—END ELEVATION OF ENGINES, SHOWING FOUNDATION.

ly. The generators are capable of carrying 25 per cent overload for a period of at least half an hour without undue sparking or heating. One of the generating sets is shown in Fig. 1, and the arrangement of the generating equipment is shown in Fig. 2. This latter illustration also shows the dynamo leads extending between each of the generators and the switchboard. In addition to the generators there is a 10-kw. motor-driven booster outfit for regulating the charge and discharge of the storage battery. This is described more fully below.

STORAGE BATTERY EQUIPMENT.

For the purpose of equalizing the load and to permit shutting down the generating plant at night and at other times of light loads, and also in order to have a separate source of supply in case of accident to any portion of the steam equipment, a storage battery equipment was added to the generating plant. The battery equipment consists of 60 cells, furnished by the Electric Storage Battery Company; the trade name of the cell is G—43. The approximate size of the plates is 15½ ins. square, and the capacity of the battery at the 10-hour (normal) rate of discharge is 2500 ampere-hours; at the 5-hour rate of discharge it is 2000 ampere-hours. The normal rate of charge and discharge is 312 amperes, and the maximum rate of charge and discharge is 1000 amperes. The e.m.f., when fully charged, is 2½ volts, and at the end of discharge 1.85 volts per cell. The watt-hour guaranteed efficiency is 75 per cent, and the ampere-hour efficiency is guaranteed at 85 per cent.

The general arrangement and grouping of the cells is shown in Fig. 2. The tanks are of wood, lined with lead, and are supported on porcelain insulators. The floor of the battery room consists of special vitrified square blocks laid over concrete. By sweating the plates to lead bus-bars, absolute and secure contacts are obtained without mercury or mechanical connections. The connections between two cells more or less separated from each other are made by means of leaded copper bars, afterward painted with insulating compound.

The motor of the booster set is shunt-wound for 115 to 120 volts, and has a capacity of 15 brake horse-power at a speed of 750 r.p.m. The booster dynamo is also shunt wound for a normal e.m.f. of 30 volts at a full-load current of 333 amperes. By means of a regulating rheostat in series with the shunt field of the dynamo, the voltage may be reduced gradually by steps to zero.

SWITCHBOARD.

The switchboard, shown in Figs. 6 and 7, is of Knoxville gray marble, 2 ins. thick. It is built in four panels, and is approximately 24 ft. long. The right-hand middle panel, shown by both engravings, serves to control the three generators; the left-hand middle panel contains switches and instruments for the storage battery and the booster. The extreme right-hand panel (Fig. 7) is devoted to the lighting feeders, and the left-hand panel (Fig. 6) to the power feeders.

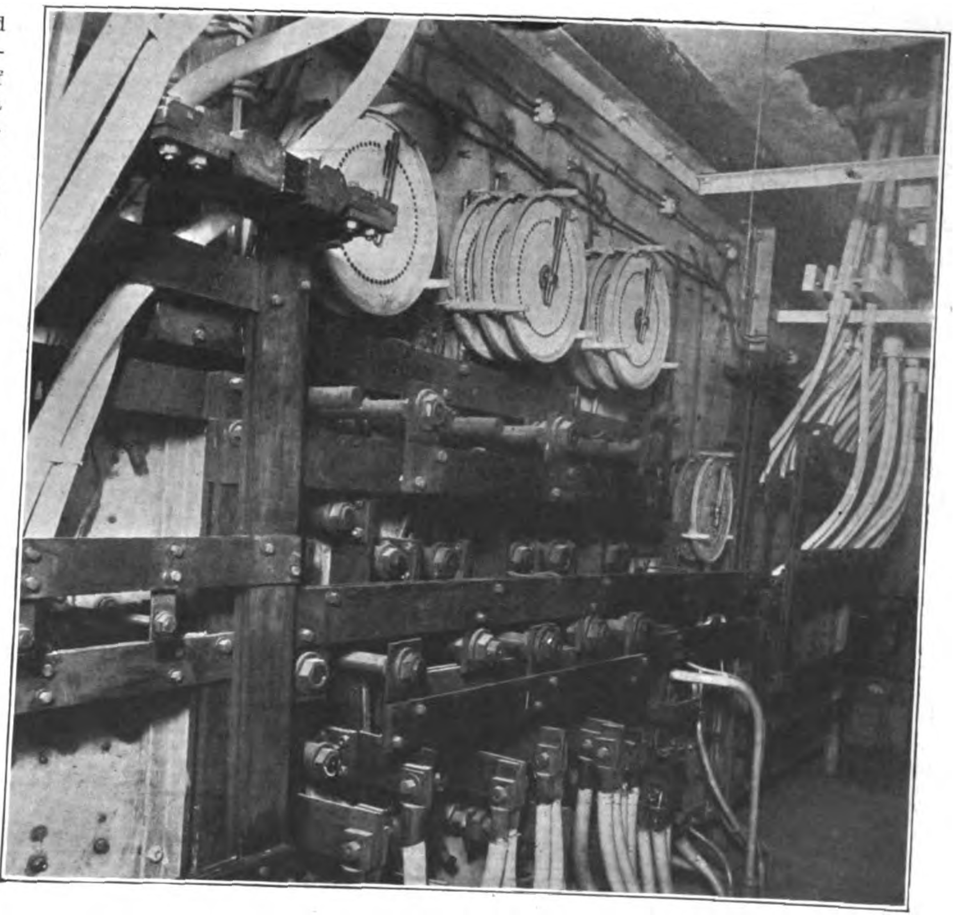


FIG. 4.—REAR VIEW OF SWITCHBOARD.

As will be seen by reference to the diagram, Fig. 5, and to Fig. 4, which shows the rear of the board, there are two sets of bus-bars on the generator panel. The upper set of bus-bars supplies current to the feeder switches on the lighting panel only, and the lower set of bus-bars supplies the power feeder switches only. Each generator connects with two triple-pole knife switches placed one above the other (see Fig. 5). The upper switch connects the generator with the lighting bus-bars, and the lower switch connects it to the power bus-bars. By closing both switches the generator supplies both sets of feeders, of course. A single-pole electromagnetic circuit-breaker is placed in the negative leg of each machine, between the dynamo and its main switch. Each of the regulating rheostats for controlling the shunt fields of the generators and the ammeters for measuring the output of each machine is placed above the corresponding generator switches, so that all the appliances for controlling each of the generators are in vertical lines, thus obviating the liability of mistakes by the switchboard operator.

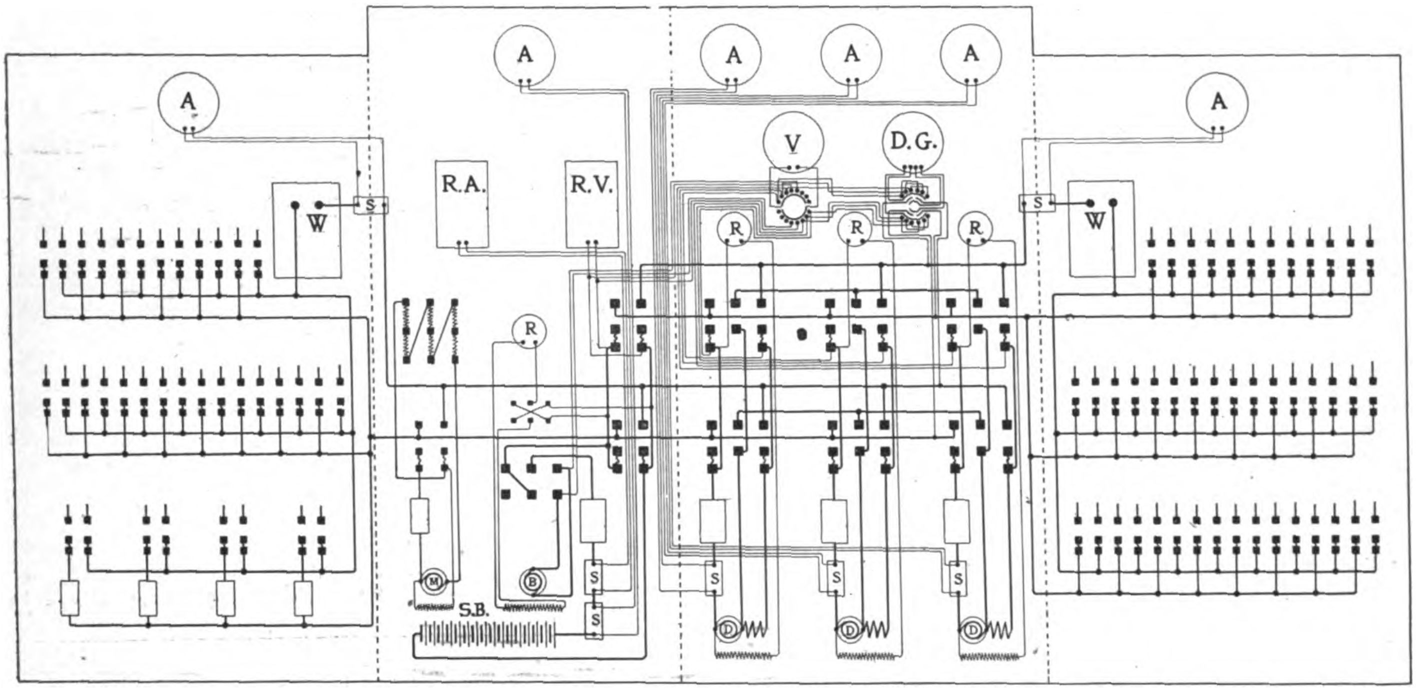
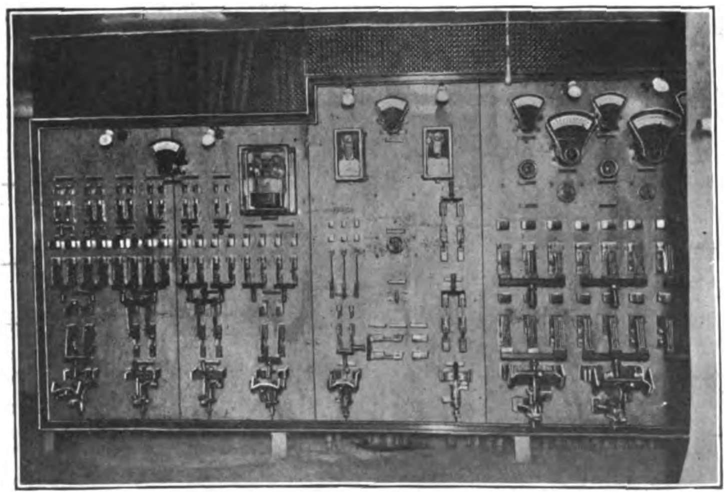


FIG. 5.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

A voltmeter and differential galvanometer are also located on this panel. By means of a multiple-point rotary switch the voltmeter may be connected to any one of the three generators, to the storage battery, the booster and to both the lighting and power bus-bars; it may also be connected by this switch between either the positive and negative bus-bars and the ground. The galvanometer is really a special voltmeter, with two coils having equal resistances and numbers of turns. The instrument is adjusted, and the scale made, with the zero position in the center.

By means of the multiple-point galvanometer switch, one machine may be connected to one of the coils and either of the other machines may be connected to the other coil. If the machines have an equal voltage, the needle will remain at zero; if the voltage of one machine is different from the other machine, there will be a deflection and the machines have to be adjusted until the needle returns to zero. When this has been done the generators may then be thrown in multiple. Mistakes are much less apt to occur in throwing machines in multiple by the use of the differential galvanometer than with the voltmeter.



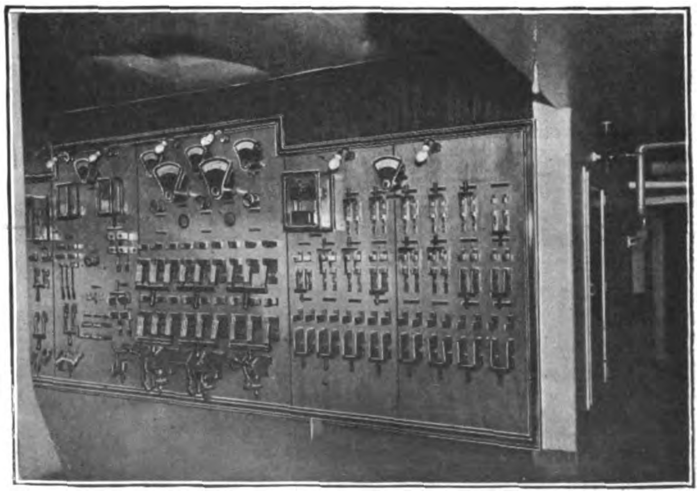


FIG. 6.—VIEWS SHOWING LEFT END AND RIGHT END OF SWITCHBOARD.—FIG. 7.

The various appliances for controlling the booster and storage battery are located on the panel to the left of the generator panel. These appliances include two single-pole electromagnetic circuit-breakers, one in the negative leg of the booster motor circuit and the other in the negative leg of the storage battery circuit. There are two double-pole switches serving to connect the battery with either the lighting or power bus-bars (or both), in the same way as described for the generator switches. A small double-pole double-throw switch serves to excite the (shunt) field in either direction. The larger double-pole double-throw switch serves to throw the booster in series with the battery (if the switch is thrown right), or to connect the battery direct to the bus-bars (if thrown to left). The booster motor armature connects with a double-pole knife switch through the motor-starting resistance.

The motor-starting resistance is arranged in six sections, and is connected with three single-pole double-break knife switches. By closing each of these switches slowly in turn, the resistances which are in series with the motor armature are cut out and the motor is started gradually, yet quickly, and without a sudden inrush of current. An ammeter, having a two-way scale, with the zero point in the center, is used to measure the charging and discharging rate of the battery current. The method of operating the booster and storage battery equipment is as follows:

When it is desired to charge the battery, the circuit-breaker and switch connecting with the booster are closed, exciting the booster motor field and putting current through the armature in series with the starting resistance; the armature is then brought up to speed by closing the small switches mentioned above. When the last one of these switches is fully closed, and the motor is driving the booster at full speed, in order to charge the battery the small double-throw booster field switch (directly over the large double-throw switch) is thrown in the proper direction to have the booster generator act in the direction necessary to raise the generator voltage. The booster field rheostat is then adjusted so that the booster e.m.f. is about 5 volts. If it is desired to charge the battery from either the power bus-bars or from the lighting bus-bars and not from both, the corresponding double-pole single-throw battery switch (at the right hand of the battery panel) is closed, and the other left open.

This, of course, would only occur when one generator was connected with the lighting bus-bars only, and another generator connected to the power bus-bars only. If both sets of bus-bars are coupled together by the dynamo switches, it is immaterial which one of the battery switches is closed; in fact, both might be closed, as the two sets of bus-bars would be connected together on the generator panel. The next step would be to throw the booster generator armature switch to the right, throwing the booster generator armature in series with the generator supplying the charging current. The rheostat in the booster generator field is then adjusted so as to maintain a proper rate of charging current for the battery. In this case the rate of current should not exceed 300 amperes. The charge is then continued under normal conditions until the battery voltage reaches 150, at which time the battery is fully charged.

In case of discharging the battery, the large double-pole double-throw switch is thrown to the left, and the battery is then connected in multiple with the lighting or power bus-bars (depending upon which of the two battery switches is closed). If the potential of the battery is too high the booster may be used to lower the battery potential by opposing the booster voltage against the battery voltage. This is accomplished by reversing the booster field, by throwing the double-throw field switch in the opposite direction. The large double-throw switch must then be thrown to the right to connect the booster generator armature in series with the battery in the same manner as in charging. If, for any reason, the battery voltage dropped too low, the booster could be used to raise the battery potential by simply reversing the booster shunt field by means of the small double-throw switch.

The lighting feeder panel is equipped with 22 double-pole knife switches in three rows. The switches in the top row are of 100 amperes capacity each, the switches in the middle row are of 200 amperes capacity each, and those in the bottom row can carry 300 amperes each. An ammeter for measuring the total lighting load is placed in circuit with the positive lighting bus-bar. The power feeder panel is equipped with 18 double-pole knife switches in three rows. The switches in the top row are of 100 amperes capacity each, those in the middle row are of 300 amperes each, and those in the bottom row, 500 amperes each. The feeders controlled by the lowest (500-ampere) row of switches supply elevator motors, and are, therefore, also controlled by single-pole electromagnetic circuit-breakers. An ammeter serves to measure the total power of the load.

The ammeters, the voltmeter and galvanometer are astatic instruments of the shunt type, made by the General Electric Company. In addition to these instruments the board is equipped with a recording voltmeter and recording ammeter for registering the momentary variations of battery current and voltage at all times. These instruments were made by Chauvin & Arnoux, Paris, France. There are also two Thomson recording watt-hour meters, one connected in the main power bus-bars and the other in the main lighting bus-bars, so as to measure the total lighting and power loads, respectively.

ELEVATORS, ETC.

There are four electric passenger elevators, three dumb-waiters and one ash lift. One of the passenger elevators runs from the ground floor to the third floor, the other three elevators rise the full height of the building. The first-named elevator has a lifting capacity of 2000 lbs. and runs at a speed of 150 ft. per minute. The other three passenger elevators have a normal capacity of about 3000 lbs., but are capable of lifting 4000 lbs.; these elevators run at a speed of 225 ft. per minute. All of the elevators are of the Sprague single worm-gear-drum type of machine. The motors are compound wound 115-volt machines. The motor for the first-named passenger elevator has an approximate normal capacity of 15 horse-power; the remaining three motors are of about 27 horse-power each. The passenger elevators are controlled by an up-and-down and automatic-stop lever located in each car. By this lever the car may be made to run at any one of the several fixed speeds by means of a series of solenoids operating a set of resistances located near each machine in the cellar.

Two of the three dumb-waiters have a rise of about 125 ft., the remaining one having a rise of about 100 ft. These dumb-waiters are capable of lifting 200 lbs. at 100 ft. per minute. The motors operating the dumb-waiters are 1½ horse-power each. An automatic system of control is applied to these dumb-waiters; their movements are controlled by means of a series of push buttons, one located at each landing, with floor-limit switches at the machine itself. At one of the lower floors a bank of push buttons is located corresponding to the number of stopping landings of the car. Each button in the bank will send the car to the corresponding landing.

MOTORS.

There are 27 electric motors in all, having an aggregate capacity of about 270 horse-power. These motors are located on the cellar, second, seventh, eighth and roof floors. Fourteen of the motors drive fans used in connection with the ventilating system, four drive the passenger elevators, three drive the dumb-waiters, one the ash lift, one drives a house pump, two are applied to laundry machinery, one drives an ice-cream freezer, and one will serve for driving a printing press. These motors are all shunt wound (except elevator motors) 115-volt machines. They are of various makes, as they were furnished under several separate contracts. Their horse-power ranges from 1 to 30.

SYSTEM OF DISTRIBUTION.

The general distributing system of feeders and mains is shown diagrammatically in Fig. 8. The feeders, mains and branch circuits are two-wire throughout. There are 33 feeders in all, 17 of which supply lighting circuits and 16 supply motors. The principal data relating to these feeders are given in the following tables.

LIGHTING FEEDERS.

No. of feeder.	No. of distributing centers supplied.	Maximum load in amperes.	Size of wire required, B. & S.		Inside diameter of conduit required.
1	2	103	1		0.9 in.
2	2	60	00		1.25 "
3	1	62	3		0.7 "
4	2	87	00		1.25 "
5	2	97	1		0.9 "
6	1	75	0		0.9 "
7	1	70	00		1.25 "
8	2	97	000		1.25 "
9	2	113	300,000	circ. mils.	1.4 "
10	2	83	300,000	" "	1.4 "
11	2	132	300,000	" "	1.4 "
12	2	136	400,000	" "	2.25 "
13	2	27	450,000	" "	2.25 "
14	3	131	350,000	" "	1.8 "
15	3	93	300,000	" "	1.4 "
16	1	63	0000		1.4 "
17	1	71	250,000	" "	1.4 "

POWER FEEDERS.

No.	Supplies motors for	H.P. of motors.	Load in amperes.	Size of wire required, B. & S.	Inside diameter of conduit required.
18	Passenger elevator	27½	220	400,000	2.25 ins.
19	" "	27½	220	400,000	2.25 "
20	" "	27½	220	400,000	2.25 "
21	" "	15	120	No. 0000	1.4 "
22	Ash lift and pump	20	160	No. 0000	1.4 "
23	Dumb-waiters.......	4½	36	No. 2	0.9 "
24	Printing press......	2	16	No. 6	0.7 "
25	Laundry machinery	5	40	No. 4	0.7 "
26	Laundry and ice cream machinery	16	128	250,000	1.4 "
27	Ventilating fans....	33	264	400,000	2.25 "
28	" "	31	248	400,000	2.25 "
29	" "	11	88	No. 0	0.9 "
30	" "	20	160	250,000	1.4 "
31	" "	12	96	No. 0000	1.4 "
32	" "	17	136	250,000	1.4 "
33	Automobile battery charging...........	..	50	No. 0	0.9 "

The branch circuit wiring is peculiar in one respect, that is, in some cases it was not permissible to have a circuit pass from one room to an adjoining room, but it was required that it should supply lights in one room only. The reason for this was to prevent microbes or germs from lodging in an outlet in one room and passing to another room. Therefore, for certain rooms or portions of the building, such as ward rooms, operating rooms, etc., separate branch circuits were run from the cut-out circuits.

Dr. Markoe, who was at the head of the building committee, was responsible for several novel and valuable ideas in the lighting of the building. One of these was the idea of having a removable plug fixture, that is, a fixture consisting of an arm with a socket for a single lamp having a plug with a large projecting flange, the plug being fitted into a receptacle placed in the wall. Receptacle outlets were located at various places throughout the building, and these can be used either in connection with the removable plug fixture or with a plug having a flexible cord extending to a lamp.

Various lights throughout the building are controlled by dimmer resistances placed in the wall near the switch outlets. The resistances are placed in a small iron box in the wall, having a handle operating a spindle (extending through the metal cover) on which is mounted a contact arm arranged to cut in various sections of resistance wire wound on an insulated spool. The panel boards are all two-wire, and are equipped with removable fuse-holders. The trims and doors of the cut-out cabinet are set so as to come absolutely flush with the finished wall, so as to avoid dust-catching corners.

The building, which is a magnificent structure of red brick and Indiana limestone, was designed by and erected under the supervision of R. H. Robertson, architect. The electric generating plant and distributing system was designed and installed under the direction of C. O. Mailloux, electrical engineer, assisted by the writer. The specifications and plans for the heating and ventilating equipment were prepared by A. R. Wolff mechanical engineer.

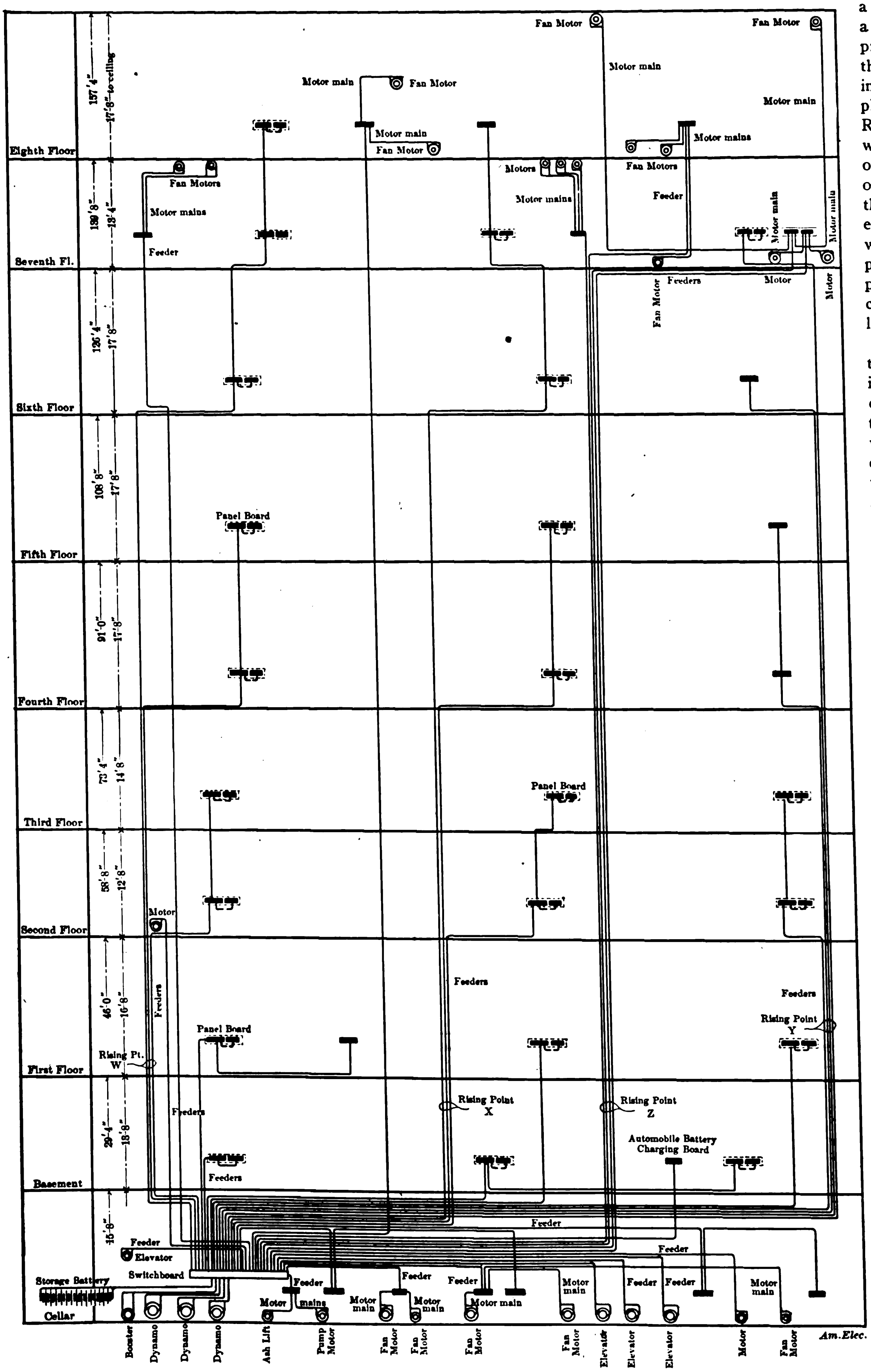

Eighth Floor
Seventh Fl.
Sixth Floor
Fifth Floor
Fourth Floor
Third Floor
Second Floor
First Floor
Basement
Cellar
157'4"
17'8" to ceiling
139'8"
13'4"
126'4"
17'8"
108'8"
17'8"
91'0"
17'8"
73'4"
14'8"
58'8"
12'8"
46'0"
16'8"
29'4"
13'8"
15'8"
Fan Motor
Motor main
Fan Motor
Motor main
Fan Motor
Motor mains
Fan Motors
Motor mains
Feeder
Motors
Motor mains
Fan Motors
Feeder
Motor main
Motor main
Fan Motor
Feeders
Motor
Motor
Panel Board
Panel Board
Motor
Feeders
Panel Board
Rising Pt. W
Feeders
Feeders
Rising Point Y
Rising Point X
Rising Point Z
Fdeders
Feeders
Automobile Battery Charging Board
Feeder
Feeder
Feeder
Elevator
Switchboard
Storage Battery
Feeder
Feeder
Feeder
Motor
mains
Motor main
Motor main
Motor main
Motor main
Feeder
Feeder
Motor main
Booster
Dynamo
Dynamo
Dynamo
Ash Lift
Pump Motor
Fan Motor
Fan Motor
Fan Motor
Fan Motor
Elevator
Elevator
Elevator
Motor
Fan Motor
Am. Elec.

FIG. 8.—GENERAL DISTRIBUTING SYSTEM OF FEEDERS AND MAINS.

The Application of the Storage Battery to Isolated Plants

BY S. E. RUCKER.

The storage battery in isolated plants may serve, as in central stations, for the storage of electrical energy to be given out at a period of light load during which the generating equipment can be completely shut down, or as a regulator to maintain a constant load on the generators with a fluctuating demand on the system, or both. There is only one set of conditions under which the installation of a storage battery would not be either a dividend payer or a convenience and that is when a plant works continuously at full load which is non-fluctuating, such as a lighting plant in a cotton mill which operates all night.

In works where the lighting plant is used only for the period from 4:30 to closing time, it is often convenient to install a small battery to supply lights in the office and at the few machines that are sometimes run overtime after the main body of the works is shut down.

Generally, isolated plants may be classified under two generic heads; which are: (1) those which operate during the day and require only a very small proportion of the plant capacity after 7 p.m., and (2) continuously-operated plants in which the total load is greatest from 6 to 9 p.m., falling off gradually and becoming a minimum in the early hours of the morning. To the first class belong office buildings and department stores; to the second, hotels and apartment houses. Usually, a mixed load of lights and elevators—and possibly other motors—is fed from the system. There is, however, the exceptional case of club houses and the like, in which the lighting load is very large in comparison to the motor load and the total may be considered as practically non-fluctuating. In this case the battery serves only to store electrical energy during the early part of the afternoon and evening in a quantity sufficient to carry the entire load after a certain time, generally 11 p.m., the boilers and machinery being shut down.

The application of storage battery equipments to isolated plants of the various types mentioned may be discussed under three sets of conditions: (1) Where the original design of the system includes the battery, the steam plant, generators and accessories being selected and arranged to meet the less arduous requirements of service in respect to overload capacity and sudden fluctuations that would be present if the battery were not installed; (2) Where the plant has been designed for a given service, the load afterward increasing beyond that originally contemplated or becoming changed in character; and (3) where the plant has been designed for a given maximum output, and though the load is not increased, the fluctuations are so marked that a battery is found to be necessary in order to get a reasonably constant load on the generating units to prevent winking of the lights on the system, reduce depreciation on the machinery, and save fuel. This last case is the result of short-sighted or incompetent design, but is often found in practice.

The simple case of systems carrying loads in club houses and buildings of a like nature will be discussed first. In this case the battery does not appreciably influence the design of the generating plant. On occasions, such as receptions, requiring an unusual amount of current for a short time, the battery may be made to assist the generating plant, but as well-designed generators can carry some overload for two or three hours without injury, this battery assistance is comparatively unimportant. The generating equipment is designed in any case for the usual daily maximum load, and the battery simply permits the shutting down of the plant when the load becomes light. The reason that the battery is of but little assistance on the load peak is that the period of maximum load extends over such a comparatively long time—usually 3 to 3½ hours—in buildings of this character, that an excessively large battery would be necessary to give a discharge that would be helpful during the "peak" period.

The battery is in this case an additional investment, and, in order to pay dividends, must be of such capacity that interest on the investment, added to cost of manufacture, will not exceed the combined saving due to decreased fuel consumption, decreased help required, and decreased depreciation on generating plant. The conveniences which arise from installing the battery are (1) longer and more advantageous hours for cleaning, repairs, and inspection; (2) stoppage of noise and pounding of machinery at bedtime; and (3) security against interruption of service on account of accidents to the generating equipment.

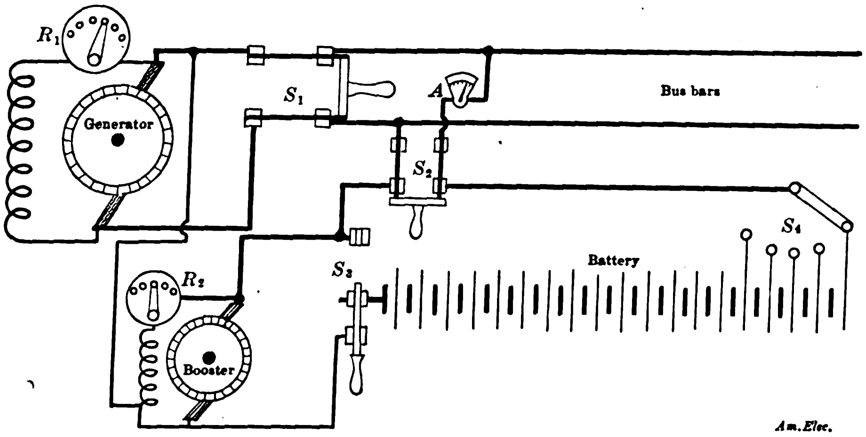


FIG. I.—METHOD OF CONNECTING UP SHUNT-WOUND BOOSTER.

Assuming 1.8 as the minimum voltage per cell of battery, and 2.2 as the maximum when discharging, the total number of cells required will be $\frac{V}{1.8}$, in which V = bus-bar voltage of the system. The number of end cells, and number of points in the end cell switch $= \frac{V}{1.8} - \frac{V}{2.2}$. Thus, in a 110-volt system, total number of cells = 61, of which 11 would be end cells.

The type of booster suitable for this plant is the plain shunt-wound machine, with connections as shown diagrammatically in Fig. 1. In this figure, R_1 is the generator field rheostat; S_1, the main switch; A, a two-way indicating ammeter; S_2, the main battery switch, by means of which the entire battery system is connected to the bus-bars; S_3 a single-pole double-throw switch; S_4 the end-cell switch, and R_2, booster field rheostat.

With S_3 closed downwards and S_4 on the outer point as shown, the system is connected to charge the battery; the charging current is adjusted by means of R_2. The connections are the same for discharge except that S_3 is thrown over to the upper contact, opening the booster circuit and connecting the battery directly to the mains, the voltage being adjusted by shifting the end-cell switch, S_4, and cutting end cells in or out as required.

Sometimes it is desirable to have the booster assist on discharge, its e.m.f. being reversed in direction and added to the battery e.m.f. In such installations R_2 must be a reversing rheostat, so that the direction of current flow in the fields can be changed, thereby reversing the booster e.m.f. as desired. It is to be noted that in this case the booster armature must be capable of carrying the maximum current of discharge and designed accordingly.

As the battery must be brought up to charge with all cells connected in series, the maximum booster voltage must be $2.7 \times n - V$, in which n = total number of cells, and V = bus-bar voltage. The figure 2.7 is voltage to which it is occasionally desirable to carry the cells on charge, known as the "boiling" point, and when done at intervals of three or four weeks for about one hour, helps to maintain the capacity of the battery. In the case just mentioned, of a 110-volt plant, with 61 cells, the maximum booster e.m.f. would be 2.7 × 61 — 110 = 54.7 volts; the machine should be capable, therefore, of giving 55 volts.

The capacity of the booster and the battery cells depends on the load curve, which must be known or assumed. Take for instance the load curve shown in Fig. 2. Under the conditions here shown, the generators would be in service from 1 p.m. to midnight, and during the following thirteen hours the entire load would be carried by the batteries. It can be seen from the chart that about 400 ampere-hours are the required battery capacity for this service. The maximum load, which lasts about three hours, is 300 amperes. Usually plants of this character are installed with two generating sets, which in this case should have a capacity of 150 amperes each. If the battery be completely discharged by 1 p.m. and one of the units started up on full load, about 125 amperes will go into the battery. This will continue, with small variations as the load changes, until 4 p.m., a period of three hours, which would represent 375 ampere-hours charge.

The first generator would be working continuously at full load, and therefore at the most economical rate. At 5 p.m. the second unit would be put into service and remain in parallel with the first one until 11 p.m., when it would be shut down. At midnight the first unit would be shut down also, putting the whole generating equipment out of service for the night.

As will be seen from Fig. 2, the additional charge required to completely fill the battery is put in during the rise and fall of the peak, when unit No. 2 is not fully loaded. In this way the load on the generators more nearly approximates their rated capacity than it could if the battery were not installed.

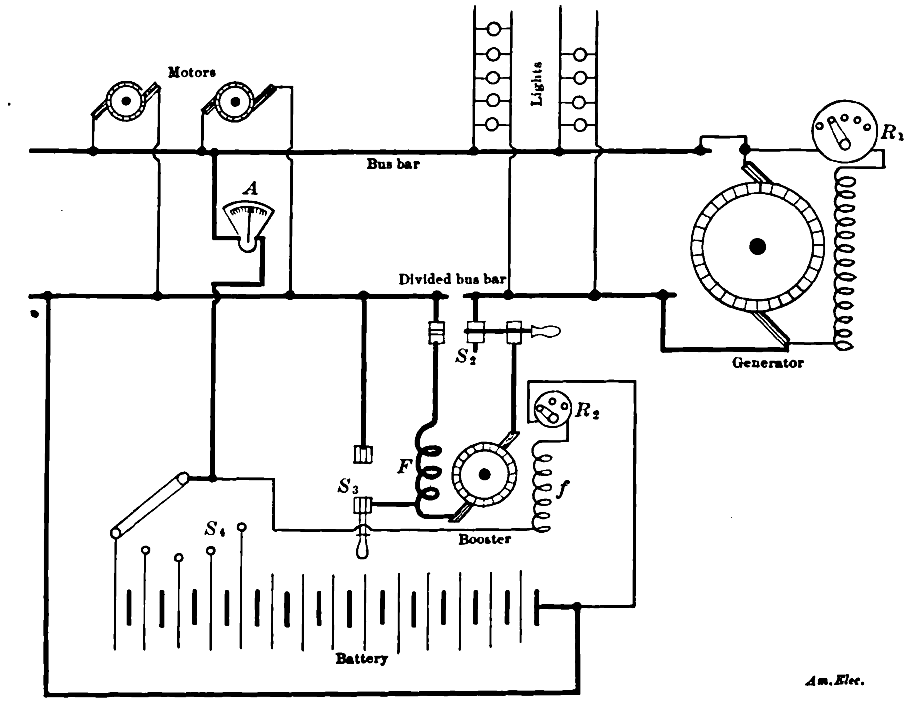


FIG. 3.—METHOD OF CONNECTION FOR DIFFERENTIAL BOOSTER.

From the foregoing it is to be seen that the current-carrying capacity of the booster armature should be 125 to 130 amperes.

The e.m.f. having been fixed at 55 volts the capacity of the machine is a little over 7 kilowatts, so that a standard 7½-kw. machine would answer. The motor to drive the booster need be only of about 6½ or 7 horsepower, for the reason that the maximum e.m.f. and current never occur at the same instant, and the booster output therefore is never equal to the full power capacity of the machine.

It is by no means to be assumed that the size of battery here taken is the most economical, without further computation. The way to determine the best size of battery from a purely financial standpoint, the question of convenience being set aside, is as follows:

Assume a given size of battery, the load curve being first plotted. This battery will permit the operation of one or more of the generating units at full load for a certain period, and a shut down for a definite time each day. The amounts of fuel used during each period of operation when the load remains fairly constant should be measured. Thus, in Fig. 2 an accurate test of the coal used from 3 a.m. to 4 p.m., during which the load varies but little, should be made; also tests of fuel consumed from 4 p.m. to 6 p.m., from 6 to 9, 9 to 10, and through each consecutive hour up to 3 a.m. The fuel consumption for one generator on full load should be known also. With these data the change in cost of operation with the battery will be:

Column 1. Additional Costs.	Column 2. Reductions.
Interest on battery equipment at 5%.	Total fuel observed as consumed from 12 midnight to 12 noon.
Depreciation on do. at 7%.	Oil and waste about 40%.
Increased coal consumption from 12 m. to 5 p. m. = coal consumption due to operation of generator on full load minus observed coal consumption from 12 m. to 5 p. m. on the light load.	Depreciation = about 33% of total depreciation, or say 1¾% on generating and steam equipment.
Note.—Interest includes only int. on difference between battery plant and plain plant complete. Depreciation = battery dep. + plant dep. — dep. on plant without battery.	Repairs about 25%.
	One shift of men.

A battery too large will bring up the interest and depreciation to such an amount that the additional costs will exceed the reductions, and conversely, a battery too small will not save enough in fuel or other items to make it of value,

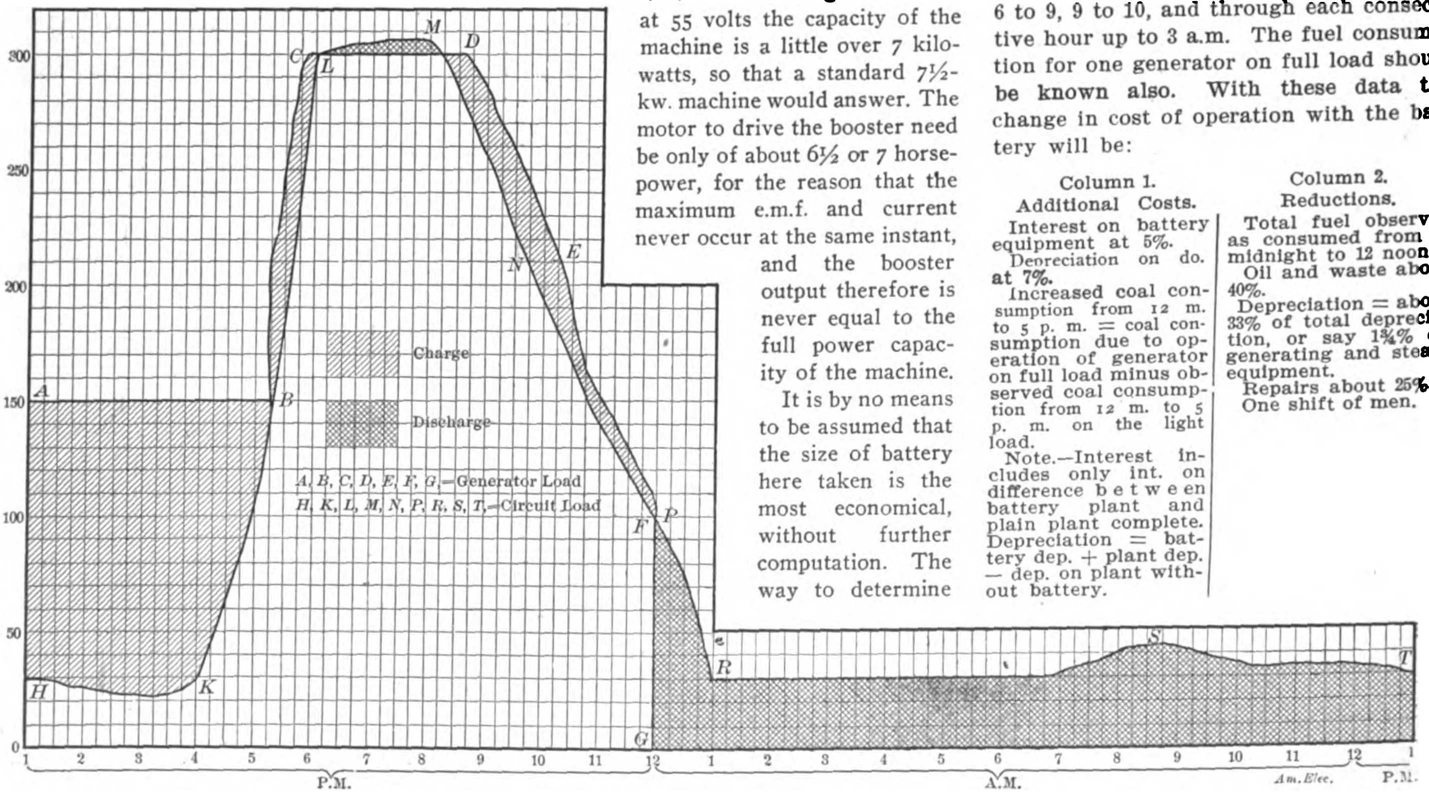


FIG. 2.—STORAGE BATTERY CHARGE AND DISCHARGE CURVES.

and its time of discharge will be too short to dispense with one shift of men. Therefore several sizes of battery should be assumed in each case, and the additional costs and reductions computed, in order to definitely arrive at the proper size of equipment to be installed.

The next case for discussion is that of the first-mentioned type of plant; where the load is fluctuating; lights and motors being both supplied from the same generators, and the run being only from, say, 7 a.m. to 6 p.m. In this case the battery is used principally as a regulator. The load is practically constant in the energy per hour required up to about 5 p.m., when the lights which have not been in use during the day are turned on. Usually this is about 60 per cent increase in the lighting load for department stores, and 75 per cent to 80 per cent for office buildings.

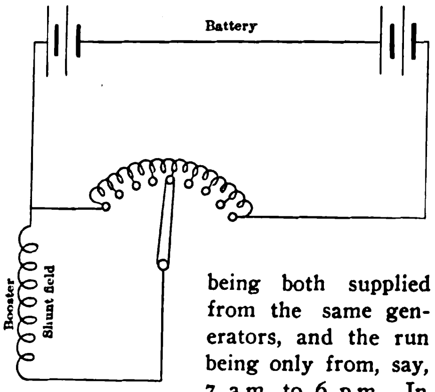


FIG. 4.

Assume as a concrete case an office building having five elevators, each using 175 amperes running and 275 on starting. Their *average* current consumption will be about 720 amperes total, assuming that there are periods of stoppage at the top and bottom floors. The lighting load during the day may be taken as 100 amperes and total lighting load in the later afternoon as 800 amperes. The average day load is then 720 + 100 = 820 amperes, and the late afternoon load is 720 + 800 = 1520 amperes.

The maximum probable current taken by the elevator motors would be with two running and three starting, or, (2 × 175) + (3 × 275) = 1175 amperes. The condition of two elevators starting at the same instant would be common with periods of rest at the top and bottom floors, and the starting of a third from an intermediate landing would be quite probable.

The maximum demand, therefore, would be 1175 + 100 = 1275 amperes during most of the day, and 1175 + 800 = 1975 amperes during the late afternoon hours. In order to maintain a constant load on the generating system the battery must store and discharge sufficient current to cover all differences between average and instantaneous values of current consumption. In the case under discussion this would be 1275 — 820 = 455 amperes, which is the fluctuation both in the morning and evening.

The battery should not discharge more rapidly than the one-hour rate, and to discharge 455 amperes for a few seconds a battery of about 450 ampere-hours capacity at the one-hour rate of discharge is required. This corresponds to about 675 ampere-hours at the three-hour rate.

The best type of booster to use in work of this kind is the "constant current," which has been thoroughly described in technical journals during the past year.* It is sufficient here to say that this machine is put in series between the generator and the variable load, and it permits only a constant and unvarying current to pass to the motor circuit. The battery is connected directly across the motor circuit, and if the booster is passing more current than is being used by the motors, the battery receives it as charge. If the motors are using a greater amount than the average, the battery must furnish the difference as discharge.

The usual practice is to install switchboards for such plants with two sets of bus-bars; one pair being connected directly to the generators from which the lighting load is supplied; and being identical in every respect to the bus-bar and switching equipment of an ordinary lighting board. The other pair of bus-bars is connected with the first pair through the booster on one side, and directly on the other, as shown diagrammatically by Fig. 3, where F is the booster series field; f, its shunt winding opposing F; S_2, a switch connecting the bus-bars together when the booster is shut down, the battery supplying all load; S_4 the end-cell switch; S_3, a switch to short-circuit the booster series field when it is necessary to charge the battery or "boil" it; R_2, the adjusting rheostat in the shunt field; and A, a two-way indicating ammeter. The main generator switch and feeder switches are omitted. It is to be noted that the booster shunt field is connected across the battery and must be designed for the battery potential.

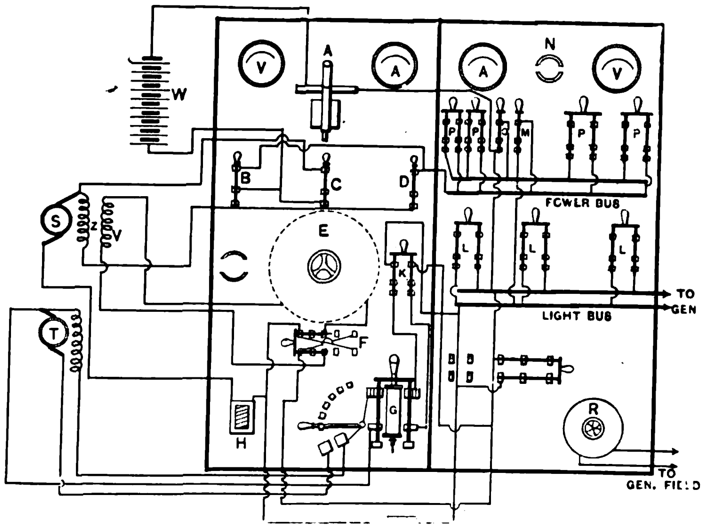


FIG. 5.—SWITCHBOARD LAYOUT FOR LARGE OFFICE BUILDING.

The booster must be large enough to pass the *average* power load continuously through it, and be capable of supplying 50 per cent excess above the normal for two hours, as it sometimes becomes necessary to send through greater currents than the normal on occasions of extraordinary demand. It is to be noted, however, that whatever may be the outside load, the booster when once adjusted will, within the limits of complete charge and discharge of the battery, deliver to the power bus-bars the current for which it is adjusted, so that whatever this current may be, it never causes any fluctuation on the generator.

The booster for the case just assumed should have a current-carrying capacity of 720 amperes, and be able to handle 1080 amperes for two hours without heating injuriously.

On the maximum voltage of the booster, that is, the voltage due to the shunt coil acting alone (the series coil being short-circuited), depends the regulation obtainable. Though termed "constant current," it is obvious that there must be some slight variation in the current to vary the booster voltage on which depends the amount of charge or discharge of the battery. This, in good practice, should be within 10 per cent, so that if the average current is 720 amperes the maximum possible draft on the generator by the power bus-bars would be 792 amperes and the minimum 648 amperes. Ten per cent should be the maximum allowable variation in isolated plant work.

If the voltage of the booster with the series coil cut out be 70 volts, the regulation will usually be within this limit. Better regulation means a larger machine. The series winding, which acts in opposition to the shunt winding should have such a number of turns that the series ampere-turns at normal current are about 10 per cent less than the shunt ampere-turns. The margin of 10 per cent is left for adjustment.

The rheostat controlling the shunt field should be connected as shown in Fig. 4. From the diagram it is to be seen that as the rheostat handle is moved to the right the potential across the shunt coils is varied from zero up to the full bus-bar potential. With a small rheostat connected in this way it is possible to vary the booster voltage from zero to maximum. The increase from one step to the next should not be more than 3 volts, or, say, 25 steps for a 70-volt booster.

Fig. 5 shows in detail the layout of a switchboard for this system which is installed in a large office building, where lights and elevators are operated from the same generators. The voltmeter and ammeter connections are omitted in order to avoid complicating the figure. These connections are as follows: One ammeter is a one-way reading instrument, connected in the circuit from the lighting bus-bar to the power bus-bar, and shows the booster current. The other is a two-way reading instrument, and is connected in series with the battery to show the charge or discharge current. One voltmeter is connected across the lighting bus-bars, and the other is connected to the voltmeter switch *N*, by means of which the voltage across the battery and the sum of the generator and booster voltages may be read.

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*Lyndon on "Storage Battery Auxiliaries," Electrical World and Engineer, July 6 and 13, 1901.

In throwing the booster into service the battery voltage is first read. Then the booster voltage is brought to such a value that, added to the generator voltage, the sum exceeds the battery voltage by about 10 volts. The circuit is then closed by means of switches *D* and *O* and the booster current adjusted to its proper value by means of the rheostat *E*. The other reference letters have the following significance: *A* is an underload circuit-breaker; *H*, overload circuit-breaker; *G*, a motor starter; *F*, a shunt-field reversing switch; *V*, a booster shunt field; *Z*, a booster series field; *S*, a booster armature; *T*, a driving motor; *P P* are power-distribution switches, and *L L* are light-distribution switches.

When operating under normal conditions switches *C* and *M* are opened, the others remaining closed. The switch *C* short-circuits the booster series field and *M* cuts out the booster entirely by joining the power and lighting bus-bars together. The end cells and switches are not shown.

The motors connected across the power bus-bars (see Fig. 3) work on a variable e.m.f., which changes according to the rate of charge or discharge of the battery. It is higher on charge and lower on discharge than the normal, varying inversely as the external load. On a 110-volt circuit the probable limits between which the motors would have to work would be 110 to 140 volts, or a range of 30 volts. This, however, does not appreciably affect the operation of motors, and it is, in fact, of some benefit, since the e.m.f. falls on application or increase in load, thereby reducing the current draft to the motor which is just starting or being more heavily loaded.

The size of motor necessary to drive the booster is about one-half the kilowatt capacity of the latter. The reason the small machine can drive the larger is that the maximum volts and the maximum amperes never occur coincidently, as explained before; when one is great the other is small, and therefore the actual power output of a booster is always much less than its capacity.

Summing up, the total battery equipment for this plant would consist of 61 cells of 675 ampere-hours capacity each (3-hour rate), a 11-point end-cell switch, a differentially-wound booster of 70 volts and 720 amperes capacity, or 50 kilowatts, and a 35-h.p. motor.

The afternoon lighting load will seldom last more than two hours, and the battery, if sufficiently large, could assist in carrying the peak. The one-hour rate should, however, never be exceeded, and if a battery be required to discharge 450 amperes on regulation and 200 amperes continuously on the peak, the maximum discharge rate would be 650 amperes. On a basis of the three-hour rate, such a battery should have a capacity of at least 850 ampere-hours. Used to assist the generating machinery on the peak, it would reduce the size of the equipment required.

In this case the steam and generating equipment would require only a capacity of 1520 — 200 = 1320 amperes, which, at 110 volts, means 145.2 kilowatts. If there are two dynamos, one would be an 80-kw. and the other a 65-kw. machine. The 80-kw. dynamo would supply the all-day current *working at full load* always, and the 65-kw. machine would be thrown in to carry the afternoon lighting. The coal saving resulting from continuous operation at most efficient load, over operation on variable loads, is well known, and this advantage is a marked one.

If no battery were installed, a generator to carry all day load should be of about 1000 amperes capacity, since the maximum load will often rise to 1275 amperes. It is true that this maximum only lasts a short time, and so far as the heating effect is concerned a smaller unit would easily handle the load. The heavier generators and engines are required to withstand the racking strains due to suddenly applied loads. A comparison of mill engines, working on steady load, with railway power-house engines, operating on fluctuating loads, will show this to be a recognized fact in practice.

The unit for afternoon lighting would be a 700-ampere machine, making a total generating capacity of 1700 amperes, or say 180 kilowatts. The cost of generating equipments in plants of these sizes is about $80 per kilowatt, while the battery and booster equipments cost about $75, on the basis of the one-hour rate. The kilowatt capacity of battery required is 650 × 110 = 71.5 kilowatts. The cost, therefore, of the first plant would be $11,600 for generating equipment and $5360 for battery equipment, making a total of $16,960. The plant without the battery would cost $14,400, or $2560 less. It is easy to see that the extra investment for the battery would pay dividends, besides giving far better service.

If the load on this system came within the hotel or apartment-house class, continuing throughout the 24 hours, the battery capacity should be computed for carrying not only the peak of the load but also the total load from midnight to 7 o'clock the next morning, the plant being shut down during this period.

Assume, for instance, a day load as before, of 720 amperes average from elevators, with 100 amperes in lights, the lighting load rising to 800 amperes at 5 p. m. and continuing to 8 p. m., then dropping gradually to 150 amperes at midnight and averaging 100 amperes from that time to 7 a. m.. A 700-ampere-hour battery would be necessary to carry the night load if it started fully charged at midnight. It could therefore help carry the peak from 5 to 8 p. m., and as the load dropped off from 9 to 12, the generating units working at full capacity could put 400 ampere-hours into it.

If the battery should discharge an average of 200 amperes for two hours on the peak, its capacity would have to be 850 ampere-hours at the two-hour rate, as previously shown. Consequently, an 800-ampere-hour battery is as small as should be installed in this plant.

All battery equipments should be computed in this way, and in most cases it will be found that a battery of sufficient capacity to provide regulation while it is assisting on the peak without exceeding its maximum allowable rate of discharge will be large enough to carry the night load.

BOILER SETTING FOR SMOKE PREVENTION.

Some interesting experiences with boilers arranged for the prevention of smoke are related by Mr. R. B. Holbrook, chief engineer for the plants of the American Linseed Oil Company, who has had a wide experience with various boiler settings and arrangements for securing perfect combustion. It is well known that in order to secure perfect smokeless combustion of coal a thorough mixture of air with the volatile gases in the combustion chamber is necessary. To do this under an ordinary hand-fired horizontal return flue boiler air must be admitted above the fire, and provisions must be made for mixing the air and the gases.

In one plant under Mr. Holbrook's charge there was experienced considerable trouble in supplying steam enough to run the engine; it being necessary to force the firing during periods of heavy load. This and considerations of smoke prevention led him to make a few simple changes, with a view to improving the furnace performance. About 14 ins. back of the usual bridge wall was built an arch low enough to deflect the flame and gases downward after they had passed over the bridge wall. Back of the arch was placed another bridge wall for deflecting the flame and gases upward against the boiler shell again. The effect of these changes is to cause a thorough mixing of the air admitted over the fire with the volatile gases, because of the tortuous path that they are compelled to take. Air is admitted over the fire by the usual perforated baffle plate in the furnace door.

The coal is fired on only one-half of the grate at a time, leaving the other half free to maintain the high temperature necessary to insure the combustion of the volatile gases distilled from the green coal, as well as to facilitate the coking of the latter. In the plant in which the change above described was made, the improvement in combustion was at once forcibly demonstrated by the ease with which steam was kept up, as compared with the difficulty of so doing before. The change in the boiler setting was the only change made in the plant; all other conditions were the same.

Electrical Equipment of a Southern Newspaper Plant.

ISOLATED PLANT OF THE "DALLAS-GALVESTON NEWS."

BY LOUIS ELLIOTT.

The "Dallas-Galveston News," a pioneer newspaper of Texas, is at present one of the most prominent and prosperous of the Southwest. With the expansion incident to its prosperity came the necessity for increased facilities in all departments, and accordingly it was decided to install a complete electrical power equipment. The supervision of the electrical features was entrusted to Bion J. Arnold, of Chicago, who specified the character of the equipment to be furnished and became responsible for its proper installation and successful operation.

Local conditions made it advisable to install an isolated generating plant, and for this purpose a 75-kw. 230-volt direct-current generating unit, built by the American Engine Company, was purchased. The engine is supplied with steam from either one of two Babcock & Wilcox water-tube boilers. The entire plant is located in the basement, the coal being delivered in front of the boilers by gravity, and the ashes removed to the street grade by means of a hydraulic lift.

There is no reserve generator in the plant, reliability being secured by providing electrical connections to several outside sources. The geographical location of the central stations at Dallas and the overloaded condition of the distribution system at the time the "News" plant was started made it inadvisable to depend upon commercial 220-volt circuits during certain periods of the day. Arrangements were made, therefore, by means of suitable double-throw switches to connect the lighting circuits of the building to either the bus-bars of the 75-kw. direct-current generator or to the service connection of either one of two alternating-current commercial circuits. In a like manner the motor circuits may be connected to either of two 220-volt circuits from independent plants.

The wiring of the building has been divided into eight circuits, four for light and four for power. Each circuit starts from a properly labeled switch on the basement board and passes through a Thomson recording watt-hour-meter,

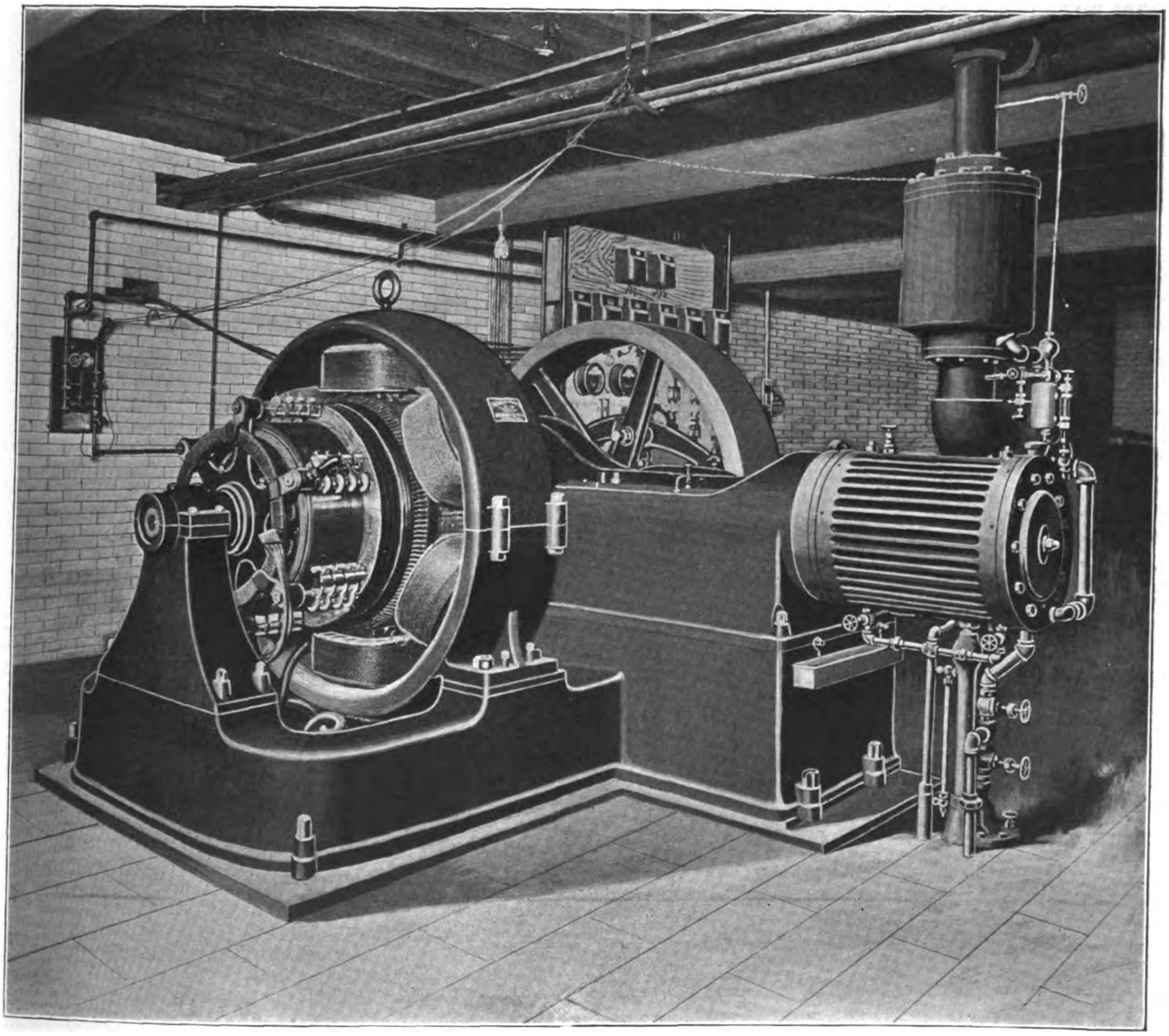

FIG. I.—GENERATING SET "DALLAS-GALVESTON NEWS" PLANT.

mounted directly above the board. Monthly readings of these meters are taken in order to determine and compare the relative amount of power used by the different departments for lights and for motors. A novel feature of this installation is the use of tell-tale meter dials located in the foreman's office in the press room. Each meter is equipped with a contact device which at each revolution of the armature energizes a magnet actuating the tell-tale dial mechanism, and thus the watt-hour-meter readings are transferred from the basement to the office. A recording voltmeter in the office also furnishes a record of the plant regulation and operation.

The wiring throughout the building is carried in iron-armored conduit. The lights for the various departments are controlled from marble distributing boards carried in iron cases built into the side walls. A complete intercommunicating system of fourteen telephones connects the desks of the chiefs of the various departments. The contract for the entire wiring work was carried out successfully by F. E. Newbery & Co., of St. Louis, Mo.

The motor equipment is most clearly considered by taking up the various mechanical departments in the order of progress of the newspaper itself. If details very familiar to a certain class of workers are brought out, it is with the intention of adding interest for those whose experience has been along different lines. In the composing room each linotype machine is driven by a ¼-h.p. motor, which is shunt-wound to give the constant speed desired through the various cycles of the machine's operation. A column proofing press and a type saw are driven by belt-connected motors. The belt of the proofing equipment runs on a friction pulley; the machine is thrown on and off by a clutch, actuated by a treadle located within easy reach.

The matrix-rolling machine is the first in the stereotyping department that is motor-driven. The motor is placed under the machine, the belt running under an idler and driving the ordinary tight pulley furnished for overhead driving. The starter is plain, with full reverse, mounted under the machine and operated by a slotted lever fastened to the belt shifter, as indicated in Fig. 2. The machine is started by the handle provided for belt shifting, stops automatically at the end of the stroke, and is started back by the same means, automatic reversing not being desired. By this control the mechanical brake for a quick stop is retained, being set by the motion of the belt-shifting device at the end of the stroke. As the motor is compound-wound the rheostat lever may be pulled over as quickly as desired without subjecting the motor to a severe overload, and the bed of the roller may thus be started faster than by the old method of shifting belts. The belt drive obviates shock to either machine in starting.

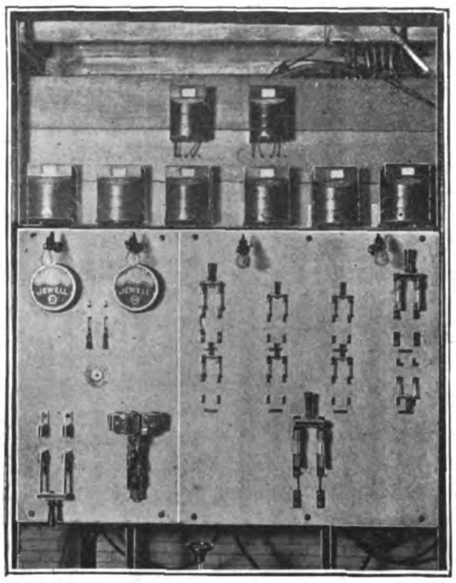

FIG. 3.—SWITCHBOARD.

Fig. 4 illustrates two stereo-plate tail cutters, with their motors, which are mounted on brackets. The required speed at the saw is obtained by gearing up; a large web-cut gear on the motor shaft driving a small rawhide pinion on the saw spindle. As shown in the engraving, a Cutler-Hammer "Universal" starter is mounted on the back of each machine, convenient to the operator, the motor being run only while sawing a plate.

The plate-shaving machine is also driven by a geared motor, the gear being double reduction in this case, as shown by Fig. 6. The machine is started by hand and automatically stops after the knife has shaved the plate and returned to its original position. A projecting lug, mounted on the worm wheel, at the proper time pushes a button located on the machine frame, and this short-circuits the retaining-magnet coil of the rheostat, releasing the arm and shutting off the current from the motor. The rheostat lever flies back past the dead point to an extra contact button, where it short-circuits the motor armature through a resistance and gives the ordinary dynamic breaking action. The quickness of stop is regulated as desired by varying the resistance through which the armature is short-circuited. The entire operative cycle of the machine consumes about 10 seconds. There are several other machines in this department, all of which are belt-driven in the ordinary manner.

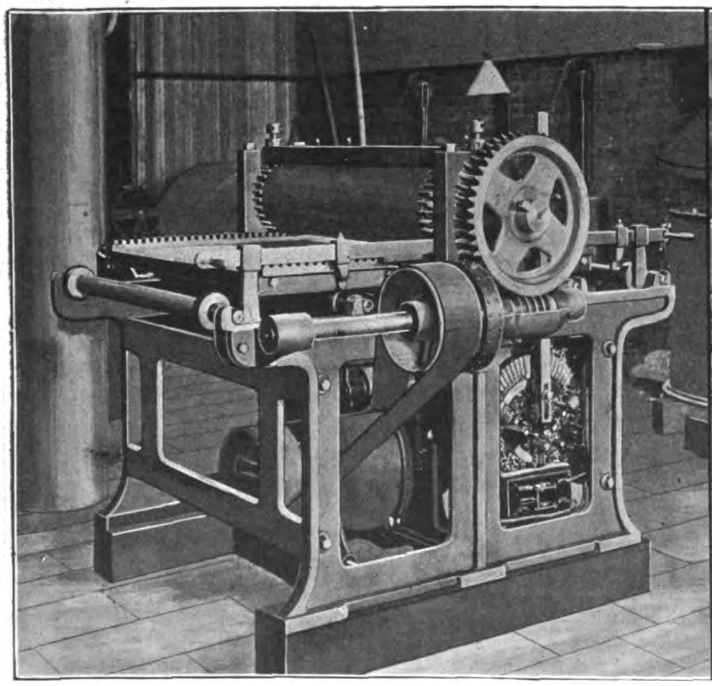

FIG. 2.—MATRIX ROLLING MACHINE.

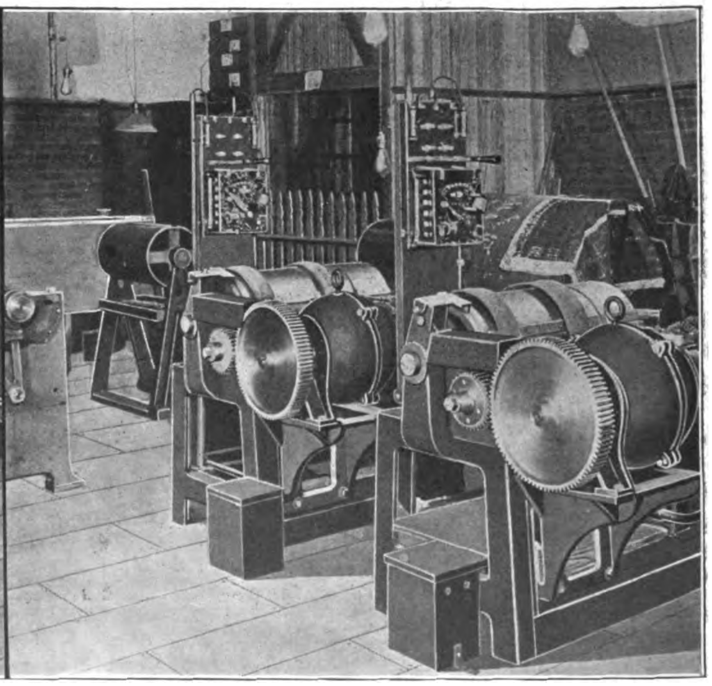

FIG. 4.—STEREO-PLATE TAIL CUTTERS.

The electrically driven machines for the photo-engraving process are router, saw and trimmer, and rocking tub. The latter equipment is shown in Fig. 5; the tub or tray is rocked by a crank motion operated through double reduction gearing, and the speed may be varied by a regulator to suit different cuts or different stages in the etching process. The router in this department is furnished with a special pair of idlers for allowing belting up from the floor instead of from above, and so arranged as to permit no variation in belt tension or power required, no matter what position the routing tool is in over the bed. From the stereotype department the plates are sent down to the press room on a small electric elevator.

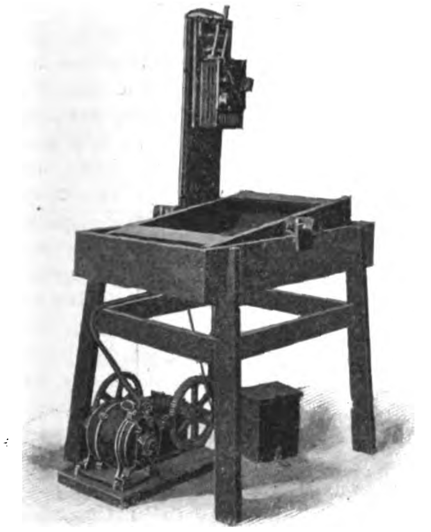

FIG. 5.—ROCKING TRAY.

The smallest of the three presses now in operation is an eight-page, arranged at present for such work as supplements. This is belt-driven by a 10-h.p. compound-wound motor, equipped with a Cutler-Hammer printing press controller of the type shown in Fig. 7. Speed control is obtained by varying armature and field circuit resistances, a slow "make-ready" speed being obtained by means of an automatically controlled armature shunt. A series of push buttons on the press frame at convenient points serve to cut the current off from the motor, and as the current flow ceases, an electromagnetic brake is set, giving a quick stop. As an illustration of the difficulties encountered in press driving, this machine takes a starting current of twice the rated full-load current and runs on a current of about one-half that at which the motor is rated.

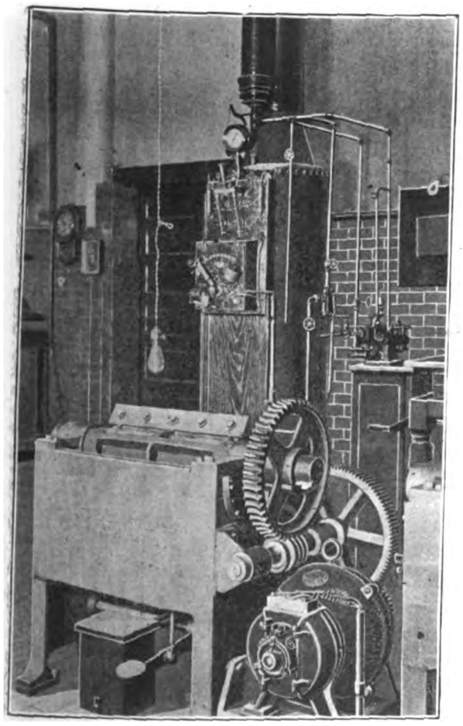

FIG. 6.—PLATE SHAVING MACHINE.

The two triple deck perfecting presses, upon which the main work is done, are driven each by a compound-wound motor, set in a pit, and belted under the floor to the press pulleys. The latter consist of the usual tight and loose pulleys, and a special narrow pulley for slow speeds, arranged in the order named, the motor pulley having a face equal to the combined widths of the three. This method of driving makes it possible to stop or start the press by either a belt-shifter or the controller, the mechanical brake being retained for a quick stop. Stops also may be made by any one of a series of push-bottons on the press. This method of connection allows the retention of a mechanical slow speed device for threading the paper through the press; the arrangement consists of the narrow press pulley above mentioned, which drives the main shaft through reduction gearing.

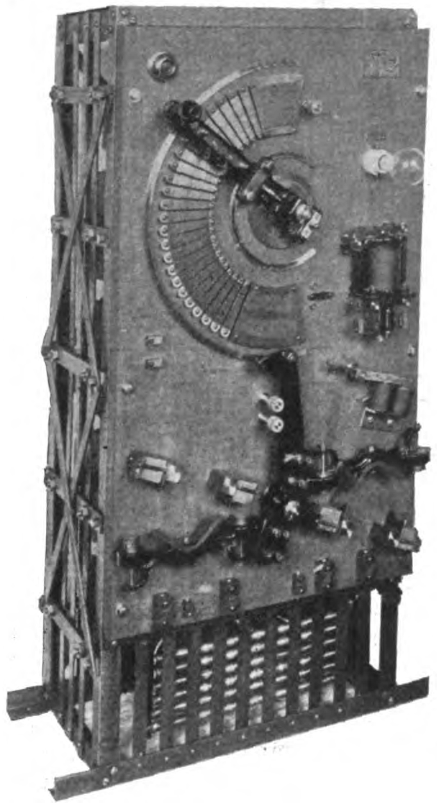

FIG. 7.—PRINTING PRESS CONTROLLER.

The controller used is also of the type illustrated by Fig. 7, and described in connection with the small press. The combination of motor speed control with the slow speed device on the press gives a most flexible system. Any speed, from a barely perceptible motion of the press cylinder, obtained by the combination of the armature shunt and the mechanical slow-speed device, to 20 per cent above normal, with the motor field weakened, can be simply and conveniently obtained.

Several other electrical devices around the building contribute to the general efficiency of the plant. A small electric elevator for copy serves the business department, editorial offices and composing room. One electric-hydraulic lift carries paper from the sidewalk to the basement, and another from the basement to the press room. A trolley hoist handles the paper rolls for the main presses. All of these devices were designed and installed by Mr. T. M. Rinehart, foreman of the "News" press department. In addition a motor-driven compressor supplies air for deep well pumping.

All wiring around presses and other machines is, of course, in iron-armored conduit, made as nearly oil-tight as possible. Lights for the presses were wired for with the same protection. The motor equipment of the plant was, with one or two exceptions, furnished by the Sprague Electric Company; this company also designed the details of motor connection to the various machines, and installed the motor plant. The first cost of such an equipment is greater than that of the old engine-driven shafting scheme; the added convenience, efficiency in the various processes of newspaper making, and power economy, has, however, been found in this case, as in many modern instances, to more than justify the extra investment.

PULVERIZED COAL BURNING IN CHICAGO.

Mention has been made in these columns at different times of the progress being made in the burning of pulverized coal. Experiments have been going on in this direction for many years, especially in Europe, but the practical means for accomplishing this end in a commercial way has not been developed in this country to any extent. It is, therefore, of interest to know that boilers in several plants in Chicago are now being fired with pulverized coal. The apparatus used is that of the Schwartzkopff Coal Dust Firing Company, of that city, which operates under the Schwartzkopff patents originated in Germany, and supplemented by the work of Mr. A. C. Hesselmeyer, technical manager for the company, who has devoted the past ten years to the study of the combustion of pulverized fuel.

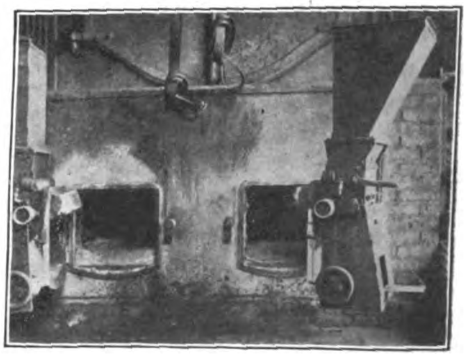

FIG. 1.—APPARATUS SWUNG TO ONE SIDE.

The principle of the apparatus used for firing this fuel is illustrated by Fig. 3, herewith. The coal must, of course, be pulverized thoroughly. In the works in Chicago is is crushed so that it will go through a screen of 100 meshes per inch. The pulverized fuel is fed from a hopper under a brush revolving at 800 to 1000 r.p.m. The revolution of this brush throws the pulverized coal into the firebox in the manner indicated. In starting up a new boiler it is necessary to build a small wood fire in the bottom of the firebox, so that the pulverized coal is sure to burn when it enters the firebox. After a run of half an hour the firebox becomes heated so that the stream of coal dust will keep afire without any other aid. Indeed, the action of this stream of pulverized coal is almost exactly similar to that of atomized oil. The particles of combustible in either case catch fire immediately and burn with an intense heat because of their small size and the consequent easy access of air to all particles of them. The supply of air, which is admitted just under the revolving brush, can be regulated very accurately to just the amount needed to secure complete combustion without having an excess and a consequent waste of fuel.

The firing apparatus, while extremely simple, is nevertheless the result of much labor in the perfection of details. The revolving brush is composed of flat steel leaves 1/32 in. thick by ⅛ in. wide. On the same shaft with the brush is an eccentric, which operates a shaking mechanism for insuring that a continuous supply of coal is fed to the brush. The shaking parts of the hopper are indicated by the dotted lines. The whole stoker is on hinges and can be swung back like a door for inspection and repairs, as shown in Fig. 1 herewith.

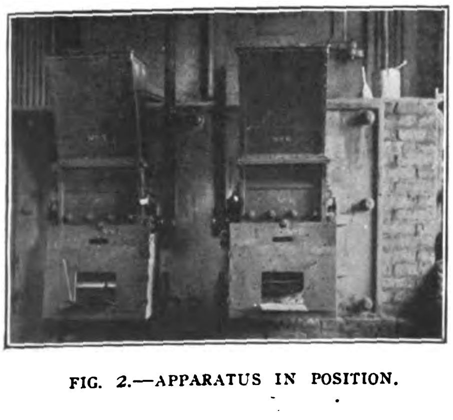

FIG. 2.—APPARATUS IN POSITION.

The advantages of pulverized coal in the way of securing complete combustion and, therefore, high economy, are almost too apparent to need explanation, and if there were any doubt about this, a glance at the furnaces so fired would dispel it, as the intense heat, similar to that produced by crude oil when atomized, is of itself ample proof. Probably one of the chief obstacles to the introduction of pulverized fuel has been the expense of pulverizing. It is positively declared now that this difficulty has been overcome and that pulverizers are now available which will reduce the coal to a sufficiently fine state at a cost of ten to fifteen cents a ton. The difficulty of pulverizing the coal has also hindered the development in Germany where pulverized fuel has been used very much more than in the United States.

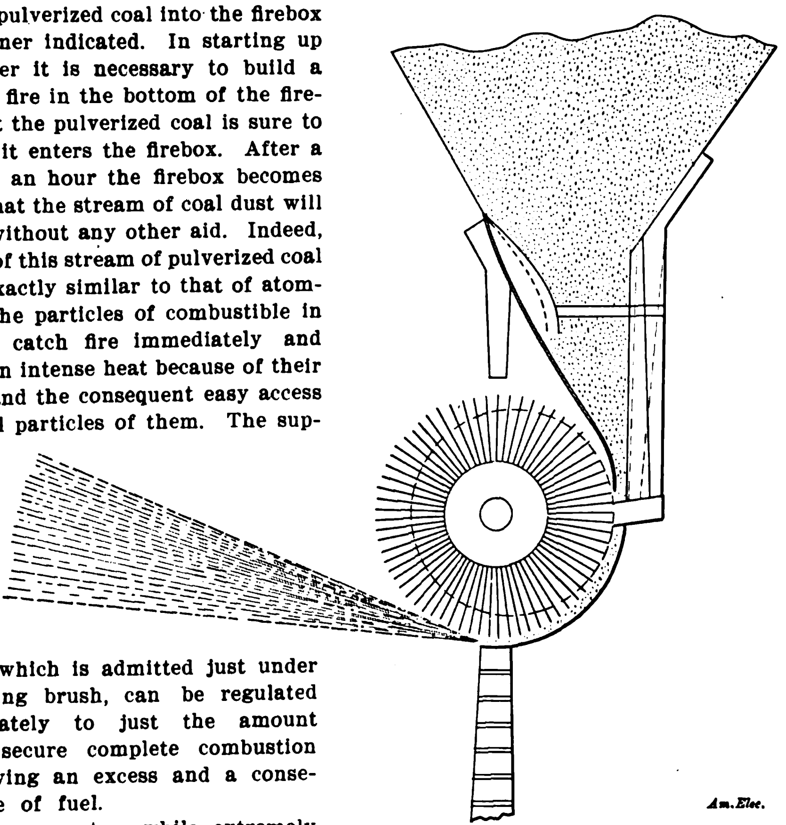
Am. Elec.

FIG. 3.—PULVERIZED COAL FEEDING APPARATUS.

That an economical means of pulverizing coal is now available is due to the development of the mining industry in America. The pulverizing apparatus used is a Clark mill, which was originally designed for pulverizing ores of different kinds previous to treatment. This mill works on the principle of a roller revolving against the periphery of a hardened steel drum. The powder in the mill is carried by centrifugal force against a 100-mesh screen. That which is sufficiently fine passes through the screen and the balance remains to be crushed finer.

As at present operated in Chicago in the Fourteenth street power house of the Illinois Central Railroad, coal dust is delivered in sacks and poured into the hoppers. The coal used is the cheapest slack that can be purchased. Comparative tests have shown an evaporation of 7½ lbs. of water per pound of coal as against 6½ lbs. in the hand-fired boilers of the same plant. In a large plant, of course, crushing and pulverizing machinery would be a part of the boiler-room equipment and the coal dust would be conveyed directly from the pulverizing mill to the stokers.

THE SIZE OF LEVER SAFETY VALVES.

BY R. A. DOUGLASS.

It is hardly necessary to say that the object of a safety valve is to prevent the pressure in a boiler from increasing beyond what is considered to be the safe limit. Bearing this object in mind, it might appear to be a simple matter to frame a rule for determining what size of valve should be used on any given boiler; but if the reader will look over the literature of the subject he will find that eminent engineers have given the greatest variety of rules for that purpose, and as hardly any two of them agree, it is by no means easy to decide which rule to follow in any particular case. Some of these rules are based on the heating surface of the boiler, some on its grate surface, some on the number of pounds of coal burned, and some on the water evaporated. In practice, a certain size of safety valve is usually assigned to a certain size of boiler without any calculation at all, on the very simple ground that experience has shown that this particular size of valve is big enough.

The right way to determine how large a valve is needed for any particular case is to estimate how many pounds of steam per hour the boiler under consideration can produce, and then make the area of the valve such that it will discharge steam at that rate. This statement is so evidently true that it hardly appears necessary to formulate it; and yet if one tries to calculate the size of a valve on this basis, one finds that there are difficulties in the way that are by no means easily surmounted.

In order to carry out this simple plan one must know two things; namely, how much steam will be discharged through an orifice of given size and shape in one minute, under known conditions of pressure, and also what actual discharge area the valve will afford. When these two items are known, the rest of the calculation becomes simplicity itself. But, unfortunately, neither of the necessary factors just specified is easy to determine with any great precision. It is known well enough how to calculate the quantity of steam that would be discharged through a short, straight pipe, in one minute, but when one passes to the consideration of openings of other forms, such as are found in safety valves, the calculation becomes very uncertain. And, too, it is not the simplest thing in the world to determine what actual area of discharge opening a proposed valve will give.

Safety valves are rated according to the sizes of their disks on the steam side. Thus a "four-inch" valve is one whose disk, on the steam side, is four inches in diameter; and such a valve, under ordinary conditions, is usually mounted on a 4-in. pipe leading from the boiler. But when this valve blows off, it never rises from its seat far enough to give the full discharge area of a 4-in. open pipe. On the contrary, it presents only an actual discharge area equal to the sectional area of a conical ring whose inner diameter is equal to the diameter of the valve disk, and whose width is equal to the perpendicular distance between the valve disk (in its raised position) and the seat.

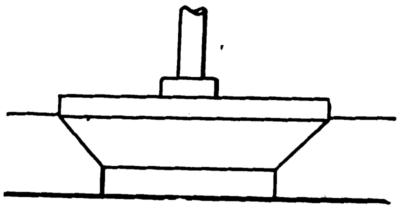

FIG. 1.—VALVE IN NORMAL POSITION.

This will be understood more clearly by referring to the accompanying sketches. Fig. 1 represents, diagrammatically, a valve at rest against its seat. Fig. 2 represents the same valve when it is raised by the steam. It will be apparent that the effective area of discharge in Fig. 2 is the conical ring whose diameter is *c d*, and whose height is the distance, *a b*. Now the diameter, *c d*, is known when the size of the valve is given; but the distance, *a b*, which can actually be realized when the valve raises under a given pressure, can be determined only by experiment. In carrying out such experiments, it has been found that a valve will rise by an amount that is amazingly small, so that Fig. 2 does not represent the actual state of the case with even approximate fairness. Even Fig. 3, in which the "lift" of the valve is shown much smaller, is grossly exaggerated, for the actual "lift" is so small that it could hardly be represented clearly on a diagram drawn to the scale of any of these sketches.

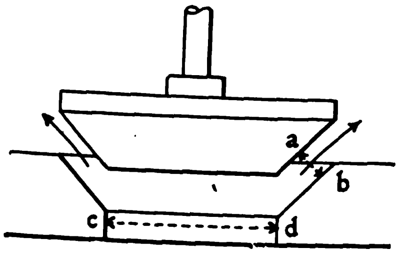

FIG. 2.—EXAGGERATED AREA OF DISCHARGE.

By the term "lift" is meant the height that the valve rises vertically from its original position in contact with the seat. In Fig. 4, for example, *e f* is the "lift" of the valve, and *a b* is the width of the conical discharge area, through which the steam makes its escape. When the "lift," *e f*, is known, the ring-width, *a b*, can be found by multiplying *e f* by the sine of the angle, *x*, that the beveled seat makes with the vertical center line through the middle of the valve. When (as is usually the case in lever valves) the angle, *x*, is about 45°, *a b* is obtained by multiplying *e f* by 0.707 (this being the sine of 45°).

Numerous experiments have been made to determine the lift of the common lever safety valve under varying conditions; but the writer will only quote those made by the United States Board of Supervising Inspectors, and published by them about 1875. Six different valve-disk areas were employed in these experiments, ranging from 5 sq. ins. to 30 sq. ins., and the valves were set so as to blow at every even 10 lbs. by the gauge, from 10 lbs. per square inch up to 100 lbs. per square inch. The results obtained are given in Table I.

TABLE I.—"Lift" of Lever Safety Valves, according to the U. S. Board of Supervising Inspectors.

Pressures at which valves were set.	Area of Valve Disc, in Square Inches. 5	10	15	20	25	30
10 lbs.	0.20	0.19	0.17	0.17	0.15	0.16
20 "	0.20	0.18	0.12	0.13	0.10	0.11
30 "	0.13	0.13	0.08	0.08	0.09	0.10
40 "	0.15	0.11	0.08	0.09	0.08	0.06
50 "	0.14	0.11	0.08	0.10	0.04	0.04
60 "	0.09	0.09	0.05	0.08	0.05	0.04
70 "	0.06	0.09	0.05	0.04	0.04	0.03
80 "	0.08	0.06	0.04	0.03	0.04	0.02
90 "	0.06	0.06	0.04	....	....	....
100 "	0.05	0.06	0.03	....	....	....

The experimental results given in Table I are doubtless correct in the main, and may safely be used as the basis of further calculations relating to the discharge capacity of lever safety valves. But they nevertheless contain several small irregularities which one cannot suppose correspond to any actual fact in nature. For example, they indicate that a valve whose disk contains 5 sq. ins. will rise 0.13 in. when blowing at 30 lbs., and that the same valve will rise 0.15 in. when blowing at 40 lbs. This is contrary to the evidence of the data as a whole, for it is plain, from the general trend of the figures, that a given valve will rise less under a heavy pressure than it will under a light one. If the results given in the table are plotted in the usual manner on a sheet of ruled paper, it will be seen that they are consistent in the main, and it is no great task to smooth out the experimental irregularities, without any material sacrifice of accuracy. The writer has done this, and the results are given in Table II. This table, it should be understood, is supposed to be the exact equivalent of Table I, except that the more obvious experimental irregularities have been smoothed out, and, for convenience of reference, the valve-disk sizes have been given in diameters, instead of in areas as in the previous table.

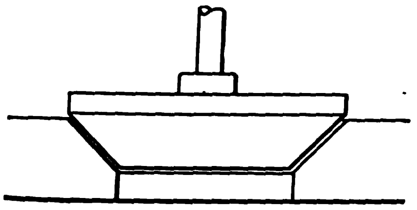

FIG. 3.—VALVE IN BLOWING OFF POSITION.

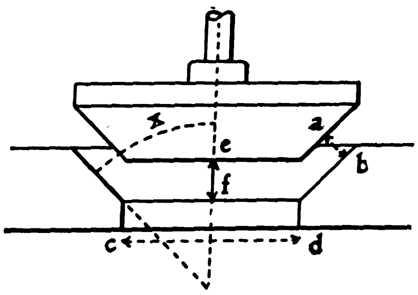

FIG. 4.—EXAGGERATED VALVE LIFT.

These results, it is fair to confess, would not naturally be anticipated by anyone. It is hardly credible that a 5-in. safety valve (for example) rises only 0.03 in., when it blows off under a pressure of 80 lbs. to the square inch. It should further be said that no experiments, however carefully they are made, can be expected to give accurately the amount by which safety valves lift in practice, for the reason that there appears to be a considerable difference in this respect between valves that are apparently alike, and that are operated under the same conditions. This fact makes it unnecessary to quote any experimental results that have been made by others, in addition to those here given, and it also serves to warn one against placing too rigid a reliance upon any results that may be deduced from experiments made in this way. We should, indeed, be able to draw certain very valuable conclusions from such experiments, but we cannot logically expect them to conform to the facts of practice in every minute detail.

TABLE II.—Showing the Corrected "Lift" of Lever Safety Valves.

Blowing pressure. (Lbs. per sq. in.)	Diameter of Valve Disk, in Inches. 2	2½	3	3½	4	4½	5	5½	6
10 lbs.	0.22	0.21	0.21	0.20	0.18	0.17	0.16	0.15	0.14
20 "	0.19	0.18	0.18	0.17	0.15	0.13	0.13	0.12	0.12
30 "	0.16	0.15	0.15	0.14	0.12	0.11	0.10	0.09	0.09
40 "	0.14	0.13	0.13	0.12	0.10	0.09	0.08	0.07	0.07
50 "	0.12	0.11	0.11	0.10	0.09	0.07	0.07	0.06	0.05
60 "	0.11	0.10	0.10	0.09	0.08	0.06	0.06	0.05	0.04
70 "	0.09	0.08	0.08	0.08	0.06	0.05	0.04	0.04	0.03
80 "	0.08	0.07	0.07	0.07	0.06	0.04	0.03	0.03	0.02
90 "	0.07	0.06	0.06	0.06	0.05	0.04	....	....	....
100 "	0.06	0.06	0.05	0.05	0.04	0.03	....	....	....

A glance at the figures given in Table II shows plainly that a large valve rises less than a small one at the same pressure, and that any valve rises less at high pressures than the same valve does at low pressures. It will not be necessary to go into the philosophy of this curious state of affairs in the present article, because it is sufficient for our immediate purpose to know what the facts are, without troubling ourselves to know the reasons for them.

Since the rise of the valve is very small, one may calculate the effective discharge area that it offers for the escape of steam by merely multiplying the circumference of the valve disk by the distance denoted by *a b* in Fig. 2. If the rise were of the same order of magnitude as the diameter of the disk, it would be necessary to take account of the fact that the discharge area is really part of a conical surface, and to calculate it by the rule for finding the convex surface of the frustum of a cone; but when the lift is as small as the table shows it to be, no sensible error will be committed if we treat the discharge area, as has been suggested, as though it were merely a ring of diameter, *c d*, and width, *a b*.

Assuming that the disk is beveled at an angle of 45°, one can find the value of *a b* by merely multiplying the corresponding lift by 0.707, as already explained. Then, having found *a b* in this manner, proceed to multiply it by the circumference of the valve disk, and the result is the effective area of discharge that the valve in question will afford. If this is done for every valve represented in Table II, the results given in Table III will be obtained.

The next step is to calculate how much steam will pass out through the valve opening per minute; and an accurate solution of this part of the problem can hardly be given. A number of nice questions arise which are not easily decided; but if one is content to pass over these niceties, Napier's rule for the outflow of steam through orifices may be used. This rule states that the number of pounds of steam that will be discharged into the atmosphere in one minute through an orifice in a boiler is approximately equal to the area of the orifice in square inches, multiplied by six-sevenths of the absolute boiler pressure in pounds per square inch. For example, if the gauge pressure is 20 lbs., the corresponding absolute pressure is 35 lbs.; and six-sevenths of this is 30 lbs., which is the weight of steam that would be discharged through an orifice 1 in. square, in one minute, under the assumed conditions. Table IV has been calculated on this basis.

TABLE III.—Effective Discharge Areas of Lever Safety Valves, in Square Inches.

Blowing pressure. (Lbs. per sq. in.)	Diameter of Valve Disk, in Inches. 2	2½	3	3½	4	4½	5	5½	6
10 lbs.	0.97	1.16	1.38	1.54	1.59	1.68	1.76	1.82	1.85
20 "	0.84	0.99	1.19	1.31	1.32	1.28	1.43	1.45	1.58
30 "	0.70	0.82	0.99	1.08	1.06	1.09	1.10	1.09	1.19
40 "	0.62	0.72	0.86	0.92	0.88	0.89	0.88	0.85	0.92
50 "	0.53	0.60	0.72	0.77	0.79	0.69	0.77	0.73	0.66
60 "	0.48	0.55	0.66	0.69	0.71	0.59	0.66	0.60	0.53
70 "	0.40	0.44	0.53	0.62	0.53	0.49	0.44	0.48	0.40
80 "	0.35	0.38	0.46	0.54	0.53	0.39	0.33	0.36	0.26
90 "	0.31	0.33	0.40	0.46	0.44	0.39	...	...	...
100 "	0.26	0.33	0.33	0.38	0.35	0.30	...	...	...

TABLE IV.—Pounds of Steam Discharged Through an Orifice One Inch Square in One Minute.

Boiler Pressure. (By Gauge.)	Pounds of Steam Discharged.
10 lbs.	21.4
20 "	30.0
30 "	38.6
40 "	47.1
50 "	55.7
60 "	64.3
70 "	72.9
80 "	81.4
90 "	90.0
100 "	98.6

It is now an easy matter to determine the discharging capacity of any lever safety valve, provided the assumptions made up to this point are admitted to be reasonable. Suppose, for example, that a 3½-in. lever safety valve is loaded so as to blow at 60 lbs. by the gauge, and it is desired to determine what weight of steam this valve can discharge per minute, without letting the pressure run up materially beyond the 60 lbs. at which the valve is set. Table III shows that the effective discharge area of this valve is 0.69 sq. in., and Table IV shows that each square inch of area will discharge 64.3 lbs. of steam per minute. The valve will, therefore, discharge $0.69 \times 64.3 = 44$ lbs. of steam (in round numbers) per minute. If a similar calculation is made for each valve and pressure represented in Table III, the results will be as given in Table V.

Considerable irregularities are evident in this table, but they cannot be avoided without unjustifiable manipulation of the experimental data. They are due, chiefly, to the fact that the data relating to the "lift" of the valves are imperfect. It is hard to measure this lift accurately to the hundredth of an inch, and the irregularities in Table V all admit of easy explanation if errors of this order were committed in the original experiments. Attention is particularly directed, in connection with this table, to what was said above about the danger of attempting to draw conclusions from the experiments in too great detail. In their very nature they are too crude for such an attempt to be justifiable. For example, we could not trust Table V implicity enough to affirm positively, on the strength of it, that at 20 lbs. pressure a 4½-in. valve will discharge precisely 2 lbs. per minute less than a 4-in. one, and 5 lbs. less than a 5-in. one, at the same pressure.

TABLE V.—Pounds of Steam Discharged by Lever Safety Valves, per Minute.

Blowing pressure. (Lbs. per sq. in.)	Diameter of Valve Disk, in Inches. 2	2½	3	3½	4	4½	5	5½	6
10 lbs.	21	25	30	33	34	36	38	39	40
20 "	25	30	36	39	40	38	43	44	47
30 "	27	32	38	42	41	42	42	42	46
40 "	29	34	41	43	41	42	41	40	43
50 "	30	33	40	43	44	38	43	41	37
60 "	31	35	42	44	46	38	42	39	34
70 "	29	32	39	45	39	36	32	35	29
80 "	28	31	37	44	43	32	27	29	21
90 "	28	30	36	41	40	35	...	...	...
100 "	26	33	33	37	35	30	...	...	...

Looking only at the broad facts of the table, however, certain interesting things stand out very clearly. All rules for calculating the sizes of safety valves (so far as the writer is aware) assume, either directly or by implication, that the discharging capacity of a safety valve is strictly proportional to the area of the valve disk. Yet the table gives no hint whatever of such a thing. For example, a 6-in. valve has nine times the disk area that a 2-in. one has, yet it is perfectly evident (if the table is good for anything at all) that a 6-in. valve will not discharge anything like nine times as much steam as a 2-in. one will discharge, at any pressure whatever.

The conclusion would be that when a 3-in. valve (for example) is not considered to be big enough for a given boiler, the remedy is not to put on a bigger one, but to put on two small ones. The general run of the figures in the table indicates that a 5-in. valve will not discharge much more steam than a 3-in. one; and hence if a 3-in. one is considered to be too small, it would be much wiser to use two 3-in. valves than to pin one's faith to a single 5-in. one. This policy could also be abundantly justified on other grounds; for the two 3-in. valves should cost less than the single 5-in. one, and it would be very unlikely that two independent valves would stick, and so become inoperative, at the same time.

It cannot be denied that the indications of Table V. are at variance with one's preconceived notions about safety valves, for it is almost impossible to believe that there is so little difference between the discharges of big valves and little ones. Yet the writer can recollect only one instance, in his own experience, in which a safety valve of any size whatever has proved too small to relieve the pressure on a boiler, and that was when a boiler house took fire and buried the boiler in a mass of fiercely burning timbers, in addition to the usual fire in the furnace under it. It is customary to put a 4-in. safety valve on a 60-in. boiler, and experience shows that a valve of this size will take care of all the steam that such a boiler can produce, when running with coal fires. According to the table, such a valve would discharge about 40 lbs. of steam per minute, or about 2400 lbs. per hour; and as this is about the evaporative duty that can be reasonably expected from a 60-in. boiler under ordinary conditions, it is evident that the table agrees with practice in this very common case, at all events. A 72-in. boiler is frequently provided with a 5-in. valve, which experience shows to be sufficient under ordinary conditions; but the writer is not prepared to say that a 4-in. valve would actually be too small, even in that case. If it would be, then the remedy would appear to be to use (say) two 3-in. valves, instead of one 5-in. one. The table indicates that two such valves would discharge much more steam than a single 5-in. one, and experience also indicates that a pair of 3-in. valves will take care of all the steam that a 72-in. boiler will generate. From all points of view, therefore, it appears to be safer and wiser to use a pair of smaller valves for such a boiler, rather than to use a single large one.

If objection is made to Table V on the ground that it disagrees with preconceived ideas, the reply would be that the method of calculation given in this article appears to be the only rational one that is available in the present state of experimental engineering. The best way to investigate the discharging capacity of a safety valve would be to measure directly the quantity of steam that passes through it. This would avoid all questionable assumptions and spare us the trouble of using formulas the accuracy of which may be questioned by those who do not like the look of the results that they give. The writer is not aware that any extensive experiments of this sort have been made; but he finds, in Peabody and Miller's "Steam Boilers," on page 240, a statement that a 2-in. pop valve was tested in this manner at the Massachusetts Institute of Technology, with the result that "the actual flow was about 95 per cent of the calculated flow." The experimental results are not given, but by using the rule that is given on page 241 of the book, assuming that the gauge pressure at which the experiment was made was 85 lbs., and taking 95 per cent of the result, it may be inferred that the actual flow was about 27 lbs. per minute. Table V gives 28 lbs. for this case, although it is computed for lever valves.

In Kent's "Pocket Book" some figures are quoted from A. G. Brown's book on the indicator. The writer has not seen this book, but as Mr. Brown gives the "lift" of the valves that he discusses to the nearest ten-thousandth of an inch, the writer has preferred to trust to the data presented above, in which no pretense is made to any such amazing accuracy. There is such a thing as too great a degree of refinement in such matters.

The whole subject of the discharging capacity of safety valves is in a most unsatisfactory condition at present, and while it would be easy to criticize the results presented in this article, it would also be hard to give any that are manifestly better. It is to be hoped that some dissatisfied critic, who is in position to do so, will provide the further experimental data that are so much needed.

As a matter of worldly wisdom, it is better not to place any great reliance upon the ability of any safety valve to relieve the pressure on a boiler; for it is always best to treat such a valve as though it were merely a high-pressure alarm, which serves its purpose if it calls the attention of the engineer or fireman to the fact that the pressure is too high. It should, of course, be large enough to take care of most of the steam that the boiler can produce, because if the draft of steam is suddenly stopped from any cause when the boiler is running at full load, the pressure may otherwise run up too high before the attendant can control it. But there does not appear to be any necessity for attempting a nice adjustment of the discharging capacity of the valve to the evaporative capacity of the boiler. Table V certainly agrees broadly with experience. Whether or not there is really as little difference between a small valve and a big one as appears from the table, must be left to future experimenters to decide.

AN INTERESTING RESIDENCE PLANT.

A most excellent example of a modern isolated plant for residence lighting and power service is afforded by the equipment recently installed at the residence of Mr. Bradford Norman, Newport, R. I., the principal features of which are illustrated by the accompanying engravings. The plant is extremely simple and compact which features, of course, are among the chief requirements for this class of installation. A 10-h.p Westinghouse gasoline engine (illustrated by Fig. 3) is belted to a 5 kw. Westinghouse multipolar dynamo of the ordinary 125-volt lighting type. In conjunction with the generating plant there are installed 60 storage cells of 120 ampere-hours capacity at normal rate. The engine and dynamo are run during the day only, for the purpose of charging the batteries and supplying energy to various motors about the place; at night the batteries take care of the load alone. This arrangement is obviously preferable for private plants of this sort where the cost of attendance after ordinary working hours would make the operation of the plant excessively expensive. As it is now operated no special attendance is required. A man-of-all-work, who would be employed irrespective of the lighting plant, gives it the small amount of attention necessary for starting up, maintaining lubrication and shutting down; there is absolutely no skilled attention given to the equipment.

As indicated above, there are several motors about the grounds. The windmill pump, for example, is provided with an

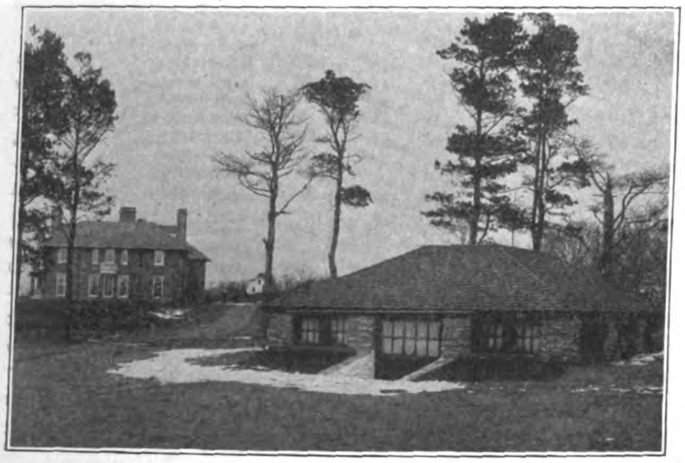

FIG. I.—POWER HOUSE.

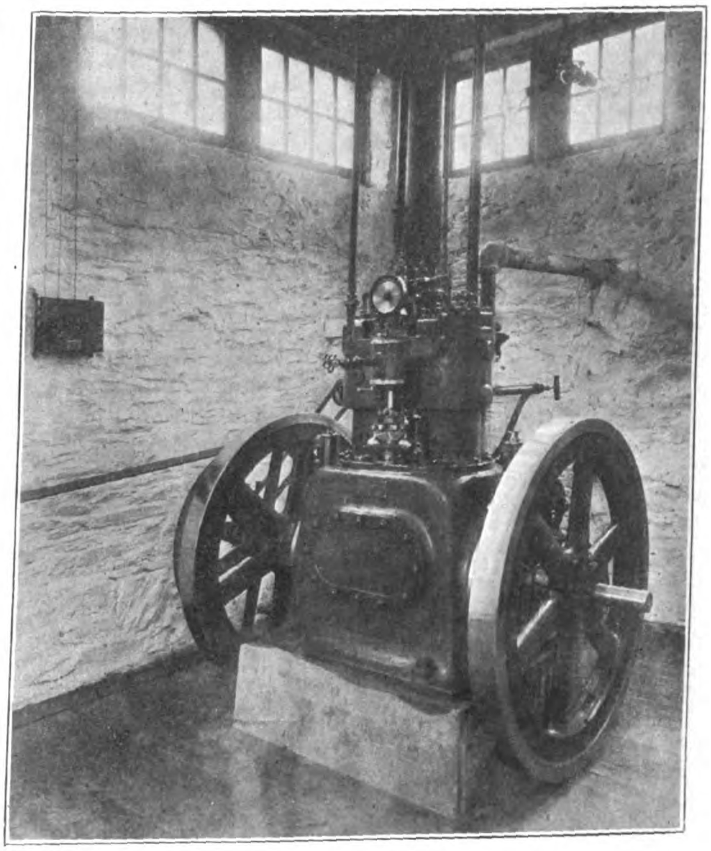

FIG. 3.—WESTINGHOUSE GASOLINE ENGINE.

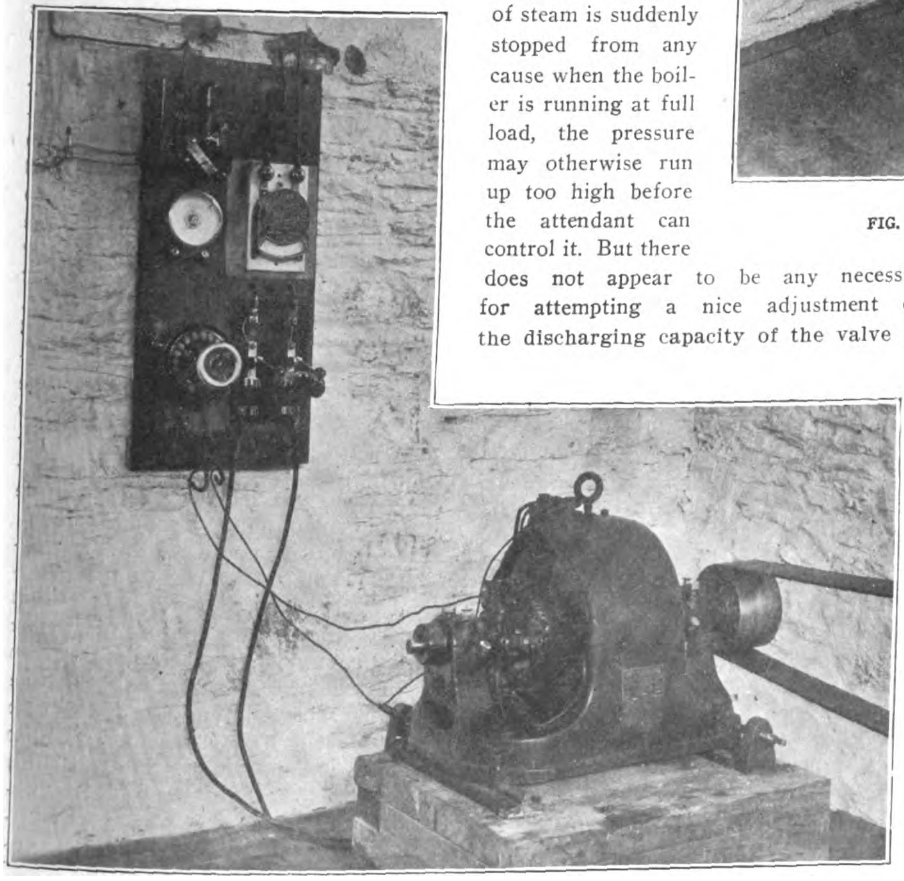

FIG. 2.—GENERATOR AND SWITCHBOARD.

auxiliary electric motor which is put into service when there is not sufficient wind to drive the windmill. In addition to this a number of barnyard machines, such as hay-cutters, corn-shellers, etc., are driven by motors. The power house is of the "root cellar" type, as shown in Fig. 1, and is located 400 ft. from the residence. The residence wiring is divided into two principal circuits, to each of which is connected up approximately one-half of the entire number of lamps, so that on special occasions when nearly all of the lamps are likely to be in use, the two circuits may be supplied independently, one from the dynamo and the other from the storage battery. This was done in order to avoid making the size of the generating plant unnecessarily large. The changes in circuit connections are effected very simply by means of two double-throw double-pole switches at the residence, which serve to separate the storage battery and one of the house circuits from the supply line and the other house circuit.

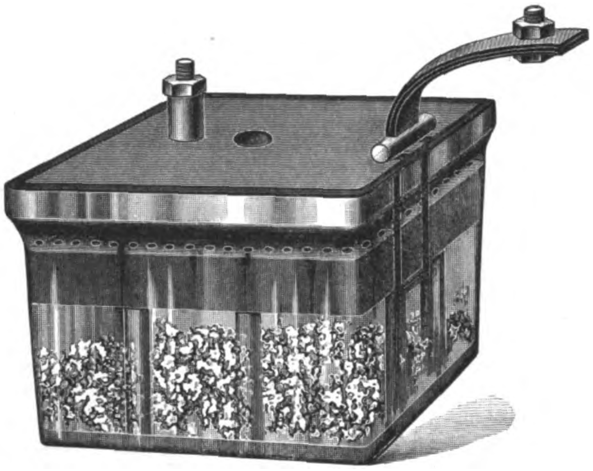

FIG. 5.—ONE OF THE STORAGE CELLS.

The storage battery is located in the residence building, so that no booster is necessary. This battery, which was furnished by the United States Battery Company, is of an unusual type commercially. It is a lead-zinc cell with the elements disposed horizontally, as indicated in Fig. 5. The positive element is made up of perforated lead sections bolted and burned together, so that if necessary one or more sections can be replaced without replacing the whole electrode. The negative element consists of zinc amalgam, which rests on the bottom of the cell, as the engraving plainly shows. This position of the negative element, it is stated, renders that element almost indestructible. One of the troubles that has been experienced with lead-zinc cells is the falling of disintegrated zinc to the bottom of the cell, causing short-circuiting; the position of the zinc element in this cell obviously eliminates any disadvantage due to this tendency. The maximum e. m. f. of the cell (when fully charged) is 2.65 volts.

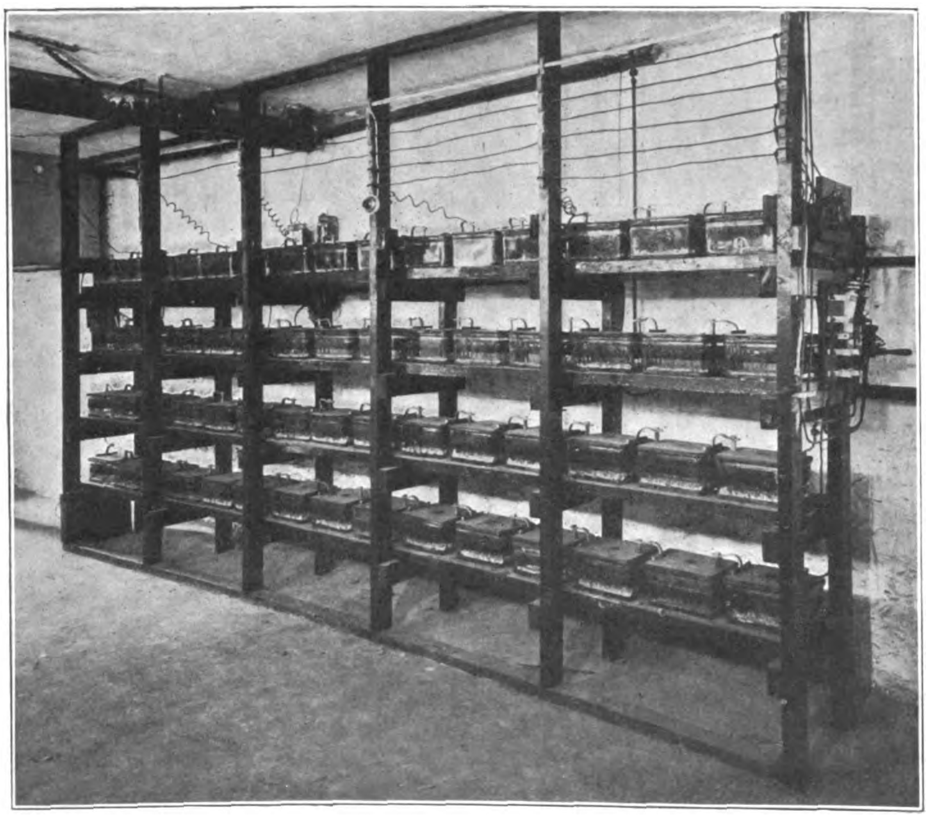

FIG. 4.—VIEW SHOWING ARRANGEMENT OF STORAGE BATTERIES.

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Government Telegraph System Proposed.—Representative Jackson, of Kansas, has introduced a bill in Congress providing for the purchase of the Western Union and Postal telegraph systems by the United States and the subsequent operation of the system by the government in connection with the Post Office Department.

STOKERS IN SMALL PLANTS.

BY A. L. HARRISON.

The use of stokers or mechanical furnaces in plants of 2000 horse-power and upward has come to be quite common, but in small plants of 500 horse-power and under, especially in electric generating stations, hand firing still largely prevails, and there is a very general conviction that while stokers may be a good thing in large plants where coal and ash handling is available, there is little or no advantage in a mechanical furnace for small plants.

The facts in reference to comparative economy are so befogged by ideas without actual facts, that it is not at all surprising that ideas rather than facts govern in this respect. Few of those who determine the equipment of large plants have as yet taken up the matter of the relative merits of the different stokers in a sufficiently serious way to make a really intelligent selection of the form of stoker to secure the best results. Too often a form of stoker is selected or endorsed because it is used in certain large plants ably manned and erected with a view to securing the best results regardless of installation cost, when in reality, so far as the stoker is concerned, no one connected with the plant could give a valid, intelligent reason for selecting that particular stoker.

One instance, which has within a year come under my observation, is an emphatic illustration of how, in most such cases the engineer "marries in haste" and the company "repents at leisure." An electric lighting company with large capital and several years' experience found their business had outgrown their plant, which had also become out of date, and the "board" determined to and did build a large, new, modern station. Condensing engines, water-tube boilers of one of the best makes were installed, and a stoker, recommended by the designing engineer and sanctioned by the boiler company, was also installed, together with coal and ash-handling machinery.

The company soon found there was difficulty about steam capacity. They continued, however, to worry along until "something had to be done." Another engineer was put in charge, a man who had established a reputation for finding out what is wrong and setting things to rights. When he told them he wanted to take out the stokers and use hand-firing the company hesitated, called in the consulting engineer, and also the boiler company's engineers, all of whom tried to persuade the engineer to give up the idea of discarding the stokers, but all to no purpose. He resolutely adhered to his position that he must have more boilers or a furnace that would give more steam from those in use.

The result was that one battery was changed and comparative results noted, which resulted in the whole plant being changed to hand-fired—the stokers going to the scrap pile. Not only was a large increased capacity secured from the boilers, but a large saving of fuel was also effected. That engineer is now dead sure no stoker could equal, much less excel, the results from hand-firing. Of course, this is not true; the company had been simply unfortunate in the selection of the stoker.

The difference in fuel economy with the best make of mechanical stoker furnace as compared with good hand-fired practice will be on test runs from 10 to 25 per cent, and on regular work will seldom fall below 25 per cent, varying according to the grade of coal used and other conditions, which vary in different districts and in each individual plant.

As an illustration of fuel economy in a small plant, an electric light company using three ordinary-sized horizontal fire-tube boilers used Pittsburg district coal, "run-of-mine" grade, because the firemen could not hold up the steam during the maximum-duty hours with a lower grade. The company had the hand-fired furnaces displaced and Murphy automatic (stoker) furnaces installed, after which screenings or slack from the same mines, costing 35 cents per ton less than the coal previously burned, was used. The tonnage for the year previous to the change and of the year following was substantially the same in round figures, 10,000 tons each year, thus showing a saving of $3,500 per annum by the use of stokers which cost, including removal of old furnaces and new full fronts with the new, not quite $3,500—the saving in one year being equal to the full cost of the installation.

In another case, an electric light company added two water-tube boilers of 150 horse-power rated capacity each, to a plant which consisted of one 72 in. x 18 ft. horizontal tubular boiler of 165 horse-power capacity rated on the same basis, *i. e.*, 10 sq. ft. of heating surface per rated horse-power. The water-tube boilers were equipped with automatic stoking furnaces.

Comparisons were made by alternate use of the fire-tube boiler, hand-fired, and of one of the water-tube boilers with the automatic furnace. It was necessary to use lump, or very coarse "run-of-mine" coal when firing by hand, in order to meet the maximum requirements for steam. In the other case Illinois screenings or slack of the same mine was used, and on test runs the stoker with the slack gave half a pound more evaporation per pound of coal used than the hand-fired gave with "run-of-mine." The difference in price was less than in the first case, but there was a saving from the use of the automatic stoker, which amounted to 25 per cent per year on the installation cost of the furnaces for the battery.

I might cite scores of similar cases where the known saving over good hand-fired practice amounts to 15 or 25 per cent of the installation cost in small plants, too small for economy in labor to enter into the financial calculation. In some cases, however, where a single boiler is used, by reason of the reduced labor required in the use of an automatic stoker, the attendant is able to fill, in whole or in part, a place which otherwise would require an additional employee.

One such case I remember, where one boiler of about 100 horse-power rated capacity, with an automatic stoker, is used, and the engineer is also fireman and attends an automatic thread-cutting machine, conveniently placed in full view of the boiler front, between the boiler and the engine. In this case there is a labor cost benefit in addition to the fuel economy, which makes the necessary extra investment for the automatic furnace pay as big returns proportionately as can be shown in any large plant where coal and ash-handling machinery are used, and the labor, as well as the fuel, is reduced to the lowest minimum cost.

My experience and observation during ten years of constant contact with boiler plants has made it clear to my mind that an intelligently-selected stoker will pay in small plants. There are very few plants, large or small, where it is not practicable to effect a saving amounting to 25 per cent or more per annum on the cost of installation and maintenance, by use of the best form of automatic stoker.

And it is also perfectly true that in a great many cases where mechanical stokers are now in use good hand-fire practice would show better results. The latter fact, due, principally, to unwise selection, is the principal cause for the erroneous idea that no stoker can beat good hand-firing; whereas, the fact is that no hand-firing, however expert, can equal the best economy of the best form of stoker furnace, whether in connection with one or with ten boilers.

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DIVIDING THE POWER IN ISOLATED PLANTS.

BY H. F. SCHMIDT.

In almost every isolated plant there is a period when only a part of the maximum output is demanded, as in the case of a hotel where during the day only a few lights are burning, and perhaps one or two elevators running, while after about 6 o'clock the full load is thrown on.

It is, of course, very uneconomical to run a steam engine under a light load; an engine running free absorbs from 10 per cent to 13 per cent of the total power developed. But in the dynamo about 5 per cent only of the total power is absorbed when run free with the fields excited, and only 3 per cent when the fields are not excited. The efficiency of a steam engine falls very rapidly when it is either overloaded or run too light, and especially in the latter case, as is shown by the result of a large number of tests made on automatic simple engines to determine the steam consumption for various loads, the average of which was found to be as follows:

¼	load	..77	lbs. per brake h.p. per hour
½	"	..47.5	" " " "
¾	"	..39.6	" " " "
Full	"	..35.6	" " " "
1¼	"	..36.6	" " " "
1½	"	..37.8	" " " "

From the preceding it will follow that in any plant where efficiency is an object, the number and size of the units chosen will be such that at all times the engine or engines running will be operated at full, or nearly full, load. However, in making this choice of size of units, attention must be paid to the number, so that an accident to one machine may not disable the plant. It is also worthy of consideration that large machines have, on the whole, a higher efficiency than small ones, hence it is better practice to have one large machine to handle the night load alone, and a small one for the day load, rather than two small machines, in which case both would be run for the heavy demand. Also in a case as just assumed in the opening paragraph, where one has a light day load and heavy night load, it would be most economical to have one large machine, and two small ones if duplicates were wanted, as then if the large machine should be crippled the two small ones might be run; or, if one of the small machines was disabled the plant would not be affected.

The following is a method by which a heavy and light load can be taken care of with the smallest first cost and yet the equipment be operated at very good efficiency:

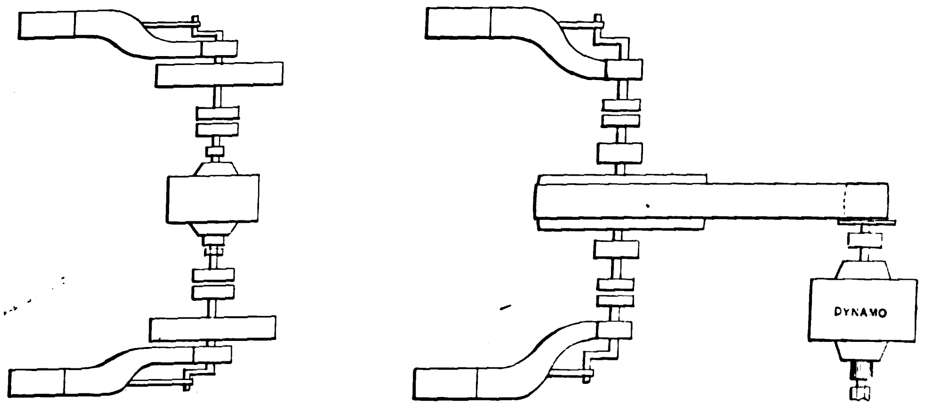

FIG. 1.—METHOD OF CONNECTING ENGINES AND DYNAMO.—FIG. 2.

The method consists in having two engines, between which the dynamo is placed (Fig. 1), the machine being coupled to the engines by two electric clutches, one at each end of the dynamo shaft. The engines are of different sizes (although they may be of the same size, in which case each would be equal to one-half the rated capacity of the dynamo), and may be arranged in two different ways, as follows: First, the large engine may be equal to the rated capacity of the dynamo and the smaller engine just large enough to carry the day load, one engine being run at a time; second, the size of the engines may be so chosen that the sum of their separate powers is equal to the capacity of the dynamo, the smaller of the two being run for the light load, and both together for the full load.

In both of these cases the steam would be used at its maximum efficiency, and the dynamo at a very good efficiency, both of which results are obtained at small first cost. If the engines are not to be direct-connected, they may be arranged as in Fig. 2, with a belt wheel between them.

To put on the second engine when the first is running it is only necessary to bring it up to full speed and then apply the clutch through the action of a small rheostat, thus taking on the load without shock. The smaller engine is then disconnected by releasing its electric clutch.

TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

PRELIMINARY WORK.

The field of action of a telephone engineer may be divided into three parts, the first comprising the design of telephone apparatus and circuits, the second including the building and maintenance of telephone plants, and the third consisting of the operation of telephone exchanges. As the first-named class of work has been so fully covered in telephone literature it will not be considered in this series of articles, except in so far as it is pertinent to an understanding of the discussion, which will be devoted chiefly to the second and third branches of the telephone engineer's work, as classified above.

A telephone exchange is always an independent organization. Usually there exists only one exchange in a city; if there are more than one they are in opposition to each other, for by the nature of the problem all subscribers in a city wish to be able to speak to all other subscribers in the same city, and this can obviously be done only when everyone is connected to the same exchange. An office may be independent, but in one case only, and that is when the exchange consists of but one office. Two or more offices forming part of a single exchange can, of course, never be independent. As a rule, the term "office" is used only when an exchange embodies more than one office.

The distance between a subscriber's instrument and the exchange office is invariably measured along the route of the line connecting the subscriber with the exchange, and such distances are almost without exception greater than the air-line distances.

The preliminary work to be done by the telephone engineer is to determine the size and location of the office or offices of the exchange. In order to proceed with this it is essential to have a map of the city, the map to be up-to-date and drawn to a comparatively large scale. Keeping in mind the fact that in all surveying work the decimal scale is used, a map drawn to a scale of 1 to 300 is to be recommended for large cities, and one of a correspondingly larger scale for smaller cities, such a map making it practical to inscribe the values of comparatively small distances. As a rule, real estate atlases or maps are available, and such should be purchased and arrangements made with the author of the map or atlas whereby he is to either keep it up to date or give notifications of changes or additions. The original map should be kept intact and free from marks, being only used for reference or to make tracings. For large exchanges a map of the city can be made from the original on a smaller scale, showing the streets only. The names of the streets should preferably be entered on the left and upper margin of the map, so as to leave the map proper free for notations. The scale of this copied map should be such as to allow the entire city to be put on a single sheet. This map will serve to lay out the underground system and pole lines also, as the pole lines feed into conduits.

If no telephone company is in existence in the particular city under consideration, a canvass should be made to ascertain the number of prospective subscribers, and the number of these for each block should be entered in black ink on the proper block of the copied map, leaving room in the block in each case for another figure in red ink to represent the present number plus the number of future subscribers that may be expected within several years to come, as a conduit system must be built for a number of years ahead, the citizens usually resenting repeated tearing up of the streets for laying additional conduit. Here the familiarity of the engineer with local conditions, as well as his judgment of probable future growth of the city with respect to its telephone users, is called into service. If there is already a telephone exchange in the city, the black figures on the copied map should represent their subscribers, who can be easily located by reference to the existing company's directory.

As a rule, not more than a single office should be used in any city; more than one office should be an exception. The benefits derived from the use of a single office may be summed up as follows: The quality of service, which should be the first consideration, is the best, as the single office allows the connections to be handled quickest and with the least amount of trouble. The percentage of trunking between offices, that is to say, the proportion of outgoing trunk calls (calls that subscribers make for subscribers connected to another office) to originating calls (the total number of calls that originate in the office), often amounts to as much as 75 per cent. This means that 75 per cent of the total calls made in the exchange must be handled by two operators, which not only requires more time, but introduces a greater liability to mistakes on the part of operators.

Trunking also introduces more apparatus in the talking circuit and the amount of office cable is increased, both of which features tend to deteriorate the quality of transmission. Moreover, no matter how good the discipline of the operating room may be, it generally happens that in the busiest hours, when the service should be most rapid, all the trunk lines are in use and subscribers are obliged to wait for connections. Overflow trunks have been provided for such emergencies, but they are a makeshift. The saving in the cost of the wire plant claimed by advocates of multiple offices is offset by the increase in the cost of the switchboard equipment necessary to handle the trunk calls, the salary of the trunk operators, and the expense for additional buildings and employees.

Next after quality of service comes the financial question. The annual expense account in a telephone plant consists of eight items, namely: (1) interest and depreciation on the wire plant; (2) interest and depreciation on the switchboard plant; (3) interest and depreciation on the subscribers' instruments; (4) interest and depreciation on buildings, or rent if the company does not own the buildings; (5) cost of operation; (6) cost of maintenance; (7) cost of current generation or supply; and (8) fixed charges. The interest and depreciation on the wire plant can be predetermined as soon as the first cost of the wire plant is known, but the first cost cannot be determined until the plant is laid out. Again, the proper number of offices to be chosen, with regard to economy only, assuming the quality of service to be good enough, regardless of the number of offices is a function of the cost of the wire plant; thus the problem seems to be an indeterminate one, and therefore to reduce to assumptions or trials; this is true to a certain extent. Nearly all other items that constitute the annual expense are functions of the number of offices.

There is at the present state of the art no difficulty in supplying 90,000 subscribers from a single office, it being possible to build a switchboard for that number of subscribers. One American company found it possible, by arranging the jacks on ⅜-in. centers, to build a switchboard for Paris containing accommodations for 9100 lines. The German Government has built a switchboard for Berlin with a capacity of 12,000 subscribers and intends to build more of similar capacity. The Hungarian Telephone Administration will erect a switchboard at Budapest, the ultimate capacity of which is specified at 20,000 subscribers. Switchboards have been installed at St. Louis and Cleveland having a capacity of 20,000 subscribers each. These boards were of the so-called "four-division" type, which is practically equal to four multiple boards, the calling subscriber being able to select a subscriber upon any one of the four by pressing one of four buttons on his instrument. By this arrangement about four times as many subscribers may be brought into one board as with a straight multiple board. By placing the jacks on ⅜-in. centers, as was done at Paris, the capacity of the four division board may be doubled. One American company builds a jack consisting of two sleeves only, which can be installed on ¼-in. centers, and with such jacks it is possible to build switchboards having a capacity of 90,000 subscribers.

It should be kept in mind that a single office, even if very large, is preferable to two or more offices, and that in order to obtain the best service it may often, if not always, be advisable to sacrifice first cost in building the plant, even if it should be found that the plant would cost more with a single office.

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FAULT FINDING ON LONG SERIES ARC CIRCUITS.

BY F. B. O'HANLON.

This article is intended to apply more particularly to underground circuits, since overhead circuits are not subjected to such trying conditions, and are therefore more free from breakdowns.

A great many serious faults may be avoided or anticipated by a systematic arrangement of daily tests. For this purpose it is necessary to have a proper testing set at the generating station, so that the actual insulation resistance can be measured. The method of testing with a bell, so largely in vogue, is not nearly good enough, as it leaves too much to the judgment of the man who turns the handle.

For tests from the station end nothing can be more convenient than a Kelvin set. With this, an ordinary sensitive galvanometer, a battery of 100 cells, and an instrument to be described, all ordinary tests can be carried out. The lineman should be provided with a portable set, and where this is combined with a telephone, the work is greatly facilitated.

In the station with which the writer is connected, it is the custom to make an insulation test every morning after the circuits are shut down; in the afternoon when the trimming has been finished and the circuits reported clear, a continuity test is taken with an ordinary galvanometer and battery, and finally, about an hour before lighting up time a trial is made with all the circuits on their respective dynamos.

With the lamps and switches in good condition there should be no difficulty in getting a large deflection on the galvanometer when using 100 cells.

Very often an apparent open circuit is only due to bad contact in a switch or to a loose connection in a lamp or other terminal. When time is limited, the best way to deal with this is to put the circuit on a machine, and by flashing its terminals endeavor to break the fault down. This failing, a man should be sent to ground the circuit in the middle, when a test to ground from the station end will show which side the fault is on. The bad side should then be subdivided until the fault is found. This will generally be in a lamp or a switch. If it is in a lamp it can be put right by switching the lamp out, of course.

Should the circuit open when it is alive it is a good plan to go around and try the effect of switching the lamps off and on again, one by one. Of course, if the circuit should happen to be open at two points, this method would be useless. It is then necessary to switch the lamps off one by one, at the same time observing the effect on the rest of the circuit. When the second fault is passed, the remaining lamps will light up, provided the faults are in the lamps. The other lamps which have been switched out should then be tried on again, one at a time, until the two faults are found.

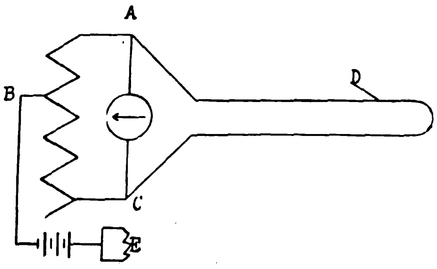

FIG. 1.—STRETCHED WIRE BRIDGE.

Open circuits are easily dealt with. Grounds are by far the most troublesome. Where possible, every lamp should be provided with a switch of a type that entirely isolates the lamp when the switch is in the off position. The majority of grounds occur in the lamps or in the leads between the switches and the lamps, and one can often get a whole group of lamps alight by merely switching off one or more lamps at the ends of a faulty section. If the fault cannot be got off in this way, it is evident that it is in the main cable between the switches, and when such is the case very little can be done without shutting down.

The circuit should be opened in the middle and an insulation test made on both sides; it may be found that only one side is grounded, and by subdividing the faulty side, the exact section can be located. Then, if the cables are laid on the draw-box system, a repair can quickly be effected; but if they are single cables on the solid system or laid direct, it will take a considerable time to effect a repair, and it is advisable, where possible, to run a jumper cable rather than continue running on the grounded main.

The bad section having been isolated, it should be cut in the middle and tested each way for the fault. Where it is possible to get the use of a return conductor, as in the case of concentric cables, the writer has found Mr. Raphael's modification of the Murray loop test to be very effective. This is simply a substitution of a stretched wire bridge for the ordinary coils, and is shown diagrammatically in Fig. 1. The wire of the bridge is taken as the equivalent of the cable loop. Then, on obtaining a balance by adjusting the position of the contact, *B*, the length of cable represented by the wire, *A B*, will equal the length, *A D*; *D* representing the fault. This, of course, only holds good when the cable is of equal section throughout; where different sections are used, the usual Murray corrections must be made.

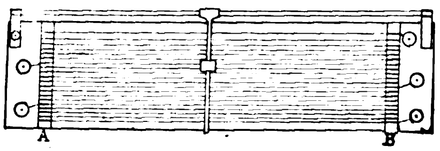

FIG. 2.—HOME-MADE BRIDGE.

Very good results have been obtained with the home-made bridge shown in Figs. 2 and 3. The base of the bridge is of wood, 36 ins. long by 12 ins. wide, and is supported at each end by feet. Platinoid resistance wire of 0.019 in. diameter is stretched between two slips of slotted ebonite, *A B*, as shown; 28 lengths having a total resistance of about 55 ohms, are used, but tappings are made at intervals. Blocks of ebonite, mounted at the ends of the board, serve as a support for a brass rod carrying a movable cross-arm; this arm carries a sliding contact which can be made to touch any portion of any of the wires. A piece of ebonite is mounted on top of the contact and serves as a handle when the instrument is being used. Binding screws are shown in Fig. 2, but are omitted in Fig. 3, which is an enlarged end view, so as to more clearly show the arrangement of the contact.

A sensitive galvanometer provided with a key should be used, and it is important not to lift the contact from the wire while the battery circuit is closed, because if this is done the wire may be injured.

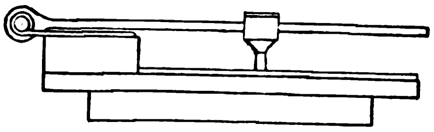

FIG. 3.—ENLARGED END VIEW OF BRIDGE.

For ordinary tests with the bridge a battery of a few accumulator cells will be sufficient, as in case of a high-resistance fault it is better to break the cable down outright before attempting to localize. The proper length of bridge wire to use can be found by experiment. Where it is possible to do so, tests should be made from both ends of the cable, and the bridge connections should be reversed so as to check results.

CONVENTION OF THE ENGINE BUILDERS' ASSOCIATION.

The third meeting of the Engine Builders' Association of the United States, which was held at Sherry's, New York, December 2 and 3, was characterized by an unusually meritorious group of papers. The first session was called to order at 2 p. m. on December 2, and opened by a short address of welcome from Vice-President W. M. Taylor, of the Chandler & Taylor Company, Indianapolis, Ind. Mr. Taylor's address was followed by a paper on "The Evolution of the Shaft Governor," by Prof. R. C. Carpenter, of Sibley College, Cornell University. Prof. Carpenter's paper was an extremely interesting historical sketch, showing the development of the shaft governor from its earliest form up to the modern Rites type.

In the discussion which followed the reading of the paper, Mr. F. M. Rites stated that the shaft governor was practically the only type that would allow close regulation on engines driving alternators in parallel. The use of this form of governor on Corliss engines, he stated, enables such engines to work successfully in conjunction with paralleled alternators where the ordinary type of Corliss governor would not be satisfactory at all. Mr. Samuel G. Neiler, a consulting engineer of Chicago, said that his experience had been that closer regulation than 4 per cent was inadvisable for engines driving alternators connected in parallel. He said that he had tried engines regulating as close as 2 per cent, but had not been able to obtain satisfactory results with closer than 4 per cent regulation, with any type of governor. Variations in angular velocity, he stated, are the chief trouble in parallel alternating-current work.

Mr. Rites said that it was possible with the use of a shaft governor to bring the engine regulation within 1 per cent; such regulation with a shaft governor, he stated, gives as good results as about 5 per cent regulation with the Corliss type of governor. He cited a case in which regulation within 1 per cent was obtained, in which case the governor was supplemented by an auxiliary device for correcting unequal divisions of load. This device, he explained, was simply the well-known arrangement for enabling a switchboard attendant to alter the cut-off of the engine valve by electro-mechanical means, and thus adjust the division of load between engines driving paralleled alternators.

Mr. Rites further mentioned an improved arrangement which he had devised for correcting unequal divisions of load. This device was electromagnetic, consisting of a differential solenoid through one winding of which the generator current passes, and through the other winding the full bus-bar current. The solenoid core operates a mechanism for varying the cut-off of the engine, and it is possible by adjusting a force opposing the solenoid core to adjust the proportion of the total load taken by any one engine. Mr. Rites referred to this device as "changing the speed" of the engine. but he doubtless meant changing the power that it delivered, as it is well known that engines driving alternators connected in parallel cannot change their speeds independently of each other.

This discussion was followed by a paper on "The Premium Plan of Labor Remuneration," read by Mr. H. M. Norris. In this paper Mr. Norris recommended the plan of paying employees the usual day wages and an additional remuneration, consisting of a premium on time saved in the performance of the various operations of the shop. His plan was, broadly, to find out from past records the average amount of time that each shop operation required and to pay an employee at the rate of his regular wages for one-half of all of the time saved in performing the same operation, in addition to the regular wages. He cited several cases where this plan had been put into effect, in one of which the time for a certain operation had been reduced 29 per cent, the operation being performed by the same man and the same machine tool as previously. Messrs. S. F. Bagg, John Dick, M. N. MacLaren, W. H. Taylor and T. C. Wood participated in the discussion of Mr. Norris' paper.

The next paper read was one by Mr. MacLaren on "Shop Administration," in which he pointed out the great advisability of laying out a manufacturing plant in such a manner that future growth may be permitted without necessitating the division of the plant into several shops—in other words, so that the various departments can be enlarged individually without affecting the integrity of the plant as a whole. He cited the Allis plant as an ideal instance of this practice. He also pointed out that the course taken by work in process of manufacture in passing through the shops should always be the same; that is to say, additions to the shops should not involve changing the course of the work through them. The paper contained some extremely good advice concerning the importance of keeping machine tools up to their highest point of efficiency. The author advocated following to a considerable extent the policy established by the large steel companies; namely, the discarding of old tools whenever new ones could be obtained to do the work more efficiently. The discussion of this paper, which was participated in by Messrs. Dick, Gates and Taylor, was short, as the soundness of the advice offered was recognized by all of those present.

Mr. Geo. T. Reiss, of the Niles Tool Works, Hamilton, Ohio, then read a paper on "Machine Shop Tools for Engine Building," which was elaborately illustrated by means of photographs and halftone engravings. In the paper the author described a number of special machine tools that had been perfected by his company for the purpose of performing two or more operations on a single engine part, and thus reducing the labor of handling heavy parts, as well as the time necessary to shift them from one tool to another and perform the operations in sequence. Like Mr. MacLaren's paper, the recommendations contained in this one were heartily concurred in by all of the builders present, so that there was not much discussion of the usual kind. Mr. Taylor asked Mr. Reiss what he considered good practice in the use of grinding machines for finishing shafts, and Mr. Reiss said he considered it the best practice to reduce the amount of work to be done by the grinding machine as far as possible; that is, to rough-turn the shaft down to within, say, 1/64 of an inch of the finished size, and then grind it true.

The session was closed by an excellent paper entitled "From the Consulting Engineer's Standpoint," by Mr. Neiler. The author briefly outlined the functions of a consulting engineer as recognized in this country, and strongly recommended that such engineers should keep within the scope of these functions. A consulting engineer, he stated, should not attempt to design apparatus, but should specify machinery that can be furnished by manufacturers without undue hardship. He also expressed the opinion that manufacturers could obtain best results and greatly facilitate the use of their product by supplying, with bids made to consulting engineers, complete data regarding their engines, so that discriminating selections could be made.

He strongly criticized the practice which many manufacturers follow of doing preliminary consulting engineering work for possible purchasers without charge. Such work, he pointed out, very rarely pays, and usually has to be done over again if a manufacturer really succeeds in obtaining an order. In most cases, however, he argued, a large amount of engineering information is given to persons who have no idea of buying the machinery concerning which they seek the information.

He paid tribute to the excellent work which had been done by the American Society of Mechanical Engineers and the American Institute of Electrical Engineers in establishing standards of manufacture and standardizing methods of testing. With reference to the offer which had been made by the authorities of the coming exposition at St. Louis to have full tests of all engines exhibited at the exposition, Mr. Neiler expressed the opinion that engine builders should by all means take advantage of this opportunity to have elaborate tests made.

In the discussion which followed, Mr. Dick, of the Phoenix Iron Works, pointed out that offers by exposition officials to have elaborate tests made of exhibit engines had, in the past, been delusive, and cited as an instance the positive promises made by the Chicago Exposition officials in this respect. He stated that a large number of engine builders had been induced, by the anticipation of having these tests made, to go to great expense for exhibits, but that if any tests had been made nobody had ever heard anything of them. Mr. Dick also referred to specifications as usually made up by consulting engineers, and said that it seemed unreasonable to him to have an engine bought for operation at 100 lbs. pressure and required to be made able to stand 150 lbs. pressure. Mr. Neiler, in reply to this criticism, stated that it was not his practice to make any such stipulation, except in cases where it is intended to ultimately raise the pressure in order to run the engine condensing.

Mr. Wood, of the Ball & Wood Company, said that he considered the stipulation of a bond in a consulting engineer's specifications unfair. The manufacturer took considerable risk, he stated, in building an engine and delivering it without receiving any bond from the purchaser to guarantee the settlement of the account, and he did not think that he should be required to give the purchaser a bond when the latter gave none. Mr. Neiler, in reply, stated that he never exacted bonds of engine builders except when the engine was for a municipality or a State institution, in which case a bond was legally compulsory.

Mr. Gates moved that a vote of thanks be extended to the authors of the papers which had been read, and this was unanimously and enthusiastically done, after which, on motion of Mr. Gates, the session adjourned.

At the second session of the convention, held December 3, the association confined its attention chiefly to discussing the industrial situation, especially in the engine building field, to the election of officers for the ensuing year, and some minor routine business. The following officers were elected: W. M. Taylor, of the Chandler & Taylor Company, Indianapolis, president; C. O. Gates, of the Russell Engine Company, Massillon, Ohio, vice-president; D. N. McBrier, of the Ball Engine Company, Erie, secretary, and C. S. Bonsell, of the Buckeye Engine Company, Salem, Ohio, treasurer. The two new members elected to the Council to succeed the two retiring members were Walter C. Kerr, of Westinghouse, Church, Kerr & Co., New York, and S. F. Bagg, of the Watertown Engine Company, Watertown, N. Y.

In the evening the annual banquet was served at Sherry's, with an attendance of about fifty. Mr. Walter C. Kerr acted as toastmaster. Mr. Richard H. Edmonds, of "The Manufacturers' Record," responded to the toast, "The South." He spoke of the great possibilities of that section of the country that still remain undeveloped. Mr. Charles Moore, in response to the toast, "Reciprocity," urged upon those present the necessity of the maintenance of a high tariff for the protection of American manufacturers, and wandered from his subject long enough to advocate strongly an improvement in the American Consular Service by sending trained men abroad, paying them enough to enable them to command respect among their neighbors, and keeping them in the service as long as they fill their positions creditably. The Hon. Job Hedges responded to the toast, "Successful Builders," but skilfully evaded the subject of his toast, and impressed upon his hearers the importance of their fulfilling their duties at all times as American citizens. The toastmaster then called for a few remarks from Messrs. John A. Hill, of "The American Machinist"; J. M. Wakeman, of the McGraw Publishing Company, and Louis Cassier, of Cassier's Magazine. The proceedings were closed by a few carefully selected stories told by Mr. C. L. Eidlitz, president of the Electrical Contractors' Association, New York.

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A DEPARTURE IN INCANDESCENT LAMP PRACTICE.

There is in process of development in England an interesting type of incandescent lamp, the filament of which is made of carbide of titianium instead of carbon. Another unique feature of the lamp is the bifurcation of its bulb in order to thoroughly isolate the filament shanks at and near the base, and obviate the "washing" and arcing that have been sources of much difficulty in the manufacture of high-voltage lamps. The bifurcation of the bulb is accomplished by providing a U-shaped tunnel from side to side and extending from the base up to a point near the center of the bulb, as indicated in the accompanying engraving. In the engraving, the walls of the tunnel look like a simple tube within the bulb; this is not the construction, however. There are two distinct legs to the bulb, from each of which one terminal of the filament is led out to the cap. The filament is said to be very tough and elastic, and much shorter than a carbon filament for the same voltage.

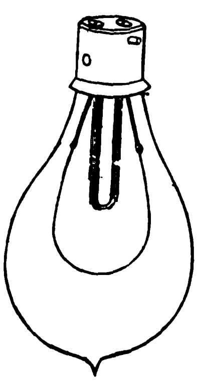

FIG. 1.—CRAWFORD-VOELKER LAMP.

The lamp is the invention of a Mr. William L. Voelker, and is known as the Crawford-Voelker lamp. A number of tests made recently in the presence of the London representative of the AMERICAN ELECTRICIAN gave the results shown in Table 1.

Volts.	Amp.	Watts.	Candle Power Hefner.	Candle Power British.	Watts. per Candle. Hefner.	Watts. per Candle. Br'h.
110	0.335	36.85	17	15	2.16	2.46
100	0.37	37	22	19.4	1.68	1.91
200	0.18	36	18	15.85	2.	2.28
200	0.17	34	17½	15.4	1.94	2.2
500	0.17	85	16½	14.1	5.15	5.85
560	0.11	61.6	10	8.8	6.16	7.

Tests previously made with 50 lamps of 16 candle-power, at 200 volts, by Col. H. C. L. Holden, Superintendent of the Woolwich royal arsenal, are said to have shown an average consumption of 2.535 watts per candle at the start; 2.845 watts after 500 hours and 3.35 watts per candle after 1000 hours. It is not stated whether the illumination was measured in Hefner units or British candles, but a comparison with the table indicates that it was in British measure.

Abstracts from Foreign Contemporaries

Connectors for Electrical Testing.—The accompanying illustrations, taken from the London "Electrical Review," show two convenient connectors, adjustable within wide limits, for electrical purposes. The conductors to be connected together are inserted in the holes, *A* and *B*, Fig. 1, and are secured in position by turning the mulled-head nuts, S_1 and S_2, so as to draw sliding pieces *m* toward them, thus tightly clamping the wires. As the wires are encircled partly by the connector tube and partly by the slides, the contact surface is broad and much more satisfactory than in the ordinary form of connector in which contact is made by the end of a screw stem pressing with more or less directness against a solid conductor, or burrowing into or between the wires of a strand. The slides, *m*, are limited in their movements both ways; the one limit being when the hole is entirely closed as in the upper sketch in Fig. 1, and the other limit being when the holes in both parts coincide, as at *A* in the lower figure. Screw terminals are also provided on the slide spindles so that additional wires may be connected at w_1 and w_2. Fig. 2 shows a single slide connector having a stout washer with a lug to which a wire may be soldered. This connector is intended for electric light conductors, and has a fly-nut which permits of a firm grip to press all the wires of the strand tightly together so as to improve their lateral contact.

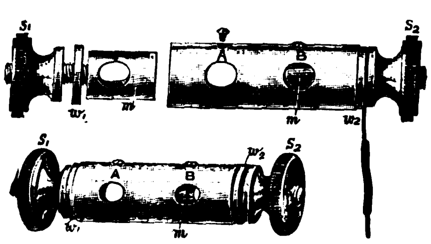

FIG. 1.—ELECTRIC WIRE CONNECTORS.

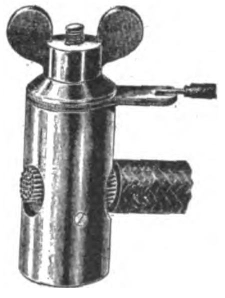

FIG. 2.—SINGLE SLIDE CONNECTOR.

Lightning Arresters.—As electric traction develops, the necessity of protecting telephone lines against stray or sneak currents becomes more apparent. This has been recognized by the telephone engineer, and suitable high voltage guards are employed at stations; but subscriber's instruments are often neglected. Fig. 3, taken from the London "Electrical Review," shows a combined lightning arrester and high-voltage guard, which is used on instruments at Glasgow. The heat coil has a nickel wire, which fuses when the current exceeds 0.25 ampere for more than 15 seconds; and a pin soldered onto a coil is pulled out by a German silver spring, thus disconnecting the instrument and preventing its being damaged by a heavy current. The lightning arrester is made of two carbon plates, between which perforated mica strips are inserted.

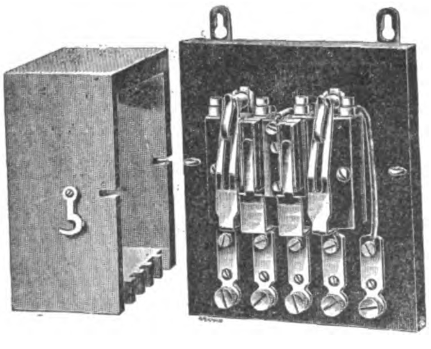
FIG. 3.—LIGHTNING ARRESTER.

Plea for the Bow Trolley.—There is one feature of car equipment in which Europe has refused to follow America; and that is in the current-collecting trolley. E. K. Scott, writing on the subject in the London "Electrical Engineer," says: "It is quite a relief to go to Germany and find the fishing-rod trolley pole almost entirely displaced by the Siemens bow trolley." Considering the advantages possessed by the different forms of trolleys, he says that the bow trolley excels in that it is impossible for it to jump the wire; it has no pins, bolts, etc., to get loose, and the actual wearing surface is always changing, so that practically no renewals are required. The rubbing contact of the bow being entirely under the wire, the overhead fittings may be made very simple, making it possible to pass over switches and around curves at a fairly good speed. The nuisance of turning around the trolley pole at terminals or *en route* when it is desired to run the car in the opposite direction is obviated in the bow trolley.

Regarding the picking up of current he refers to the experiments in Germany on high-speed traction, which have been mentioned in this paper, and which showed a highly efficient method of collecting current. It will collect larger amounts of current and admit of much higher speeds than a wheel contact, and the spring of the bow itself appears to present important advantages over the more rigid wheel construction. Another point of interest is that it is quite easy to have two bows on one car, and so break the trolley-wire connections at crossings or complicated places, in much the same way as an electric-railway train is worked, while to place two trolleys on one car would be risky and expensive.

Asphalt Conduits and Troughing.—The Howard asphalt conduit, one of the latest to appear in the conduit field, is described in the London "Electrician." As is probably well known, asphalt is a natural rock, formed by volcanic eruption, and consists of a mixture of bitumen and limestone. It is particularly suitable for pipes or conduits for electrical purposes, being an electrical insulator impervious to water and air; moreover, it resists fire and acids, and is sufficiently ductile to yield to any ordinary pressure without cracking. The difficulties of manufacture have, however, hitherto prevented the use of this material for pipes, as it does not become fluid with heat, but only acquires a pasty constituency, and will not readily flow into a mold. It also requires pressure to make it cool into a solid mass. The Howard process consists in placing the hot asphalt in a mold or sheet-iron pipe and revolving it rapidly. Owing to the centrifugal force the asphalt spreads out in a thin layer conforming to the inner surface of the pipe, and is compressed into a solid mass. In order to prevent the pipes from collapsing, a spiral of galvanized wire is combined with the asphalt, which, being embedded in the material, is consequently free from oxidation. When laying the conduit the labor in making joints is very slight. A cast-iron block of suitable shape is heated in a portable fire and applied between the two ends to be joined; when the asphalt has become sufficiently warmed the ends are pressed together firmly and left to cool, the whole operation requiring about two minutes. The troughing for use on the solid system is made on the same principle as the conduits, but without the spiral, and pressed into a rectangular shape. The cable is laid in the bottom of the trough without supporting clips, the insulating properties of the asphalt rendering these unnecessary, and just enough bitumen is poured into the trough to cover the cables. The remaining space is filled with asphalt rock, which can be arched as shown by Fig. 4, thus forming a solid cover sufficiently protecting the cable from external damage. By this method of laying, the cable is said to be so thoroughly insulated from earth that it is possible to use this as a safeguard against break-downs in case of a failure of the insulation of the cables. The arrangement for effecting this is shown in Fig. 7, where *D* is an iron box lined with asphalt, and connecting two lengths of lead-covered cable, *B*, laid in the asphalt trough, *A*. The lead sheathing of the cable is insulated from the joint box by the asphalt and is connected to earth at *E* through a resistance, *G*, and a fuse, *F*. In case of the failure of the cable causing a short circuit to the lead sheathing, and so to the earth, the fuse, *F*, is blown and the lead covering is then insulated from earth by the asphalt troughing. The cable can then be continued in service until a convenient time is found for repairing the fault. In this system the cable is divided up into sections, so the position of the fault may be found by an inspection of the fuses in the various street boxes without requiring any tests or interrupting the supply. The resistance, *G*, is intended to prevent the flow of any electrolytic currents of sufficient strength to injure the lead.

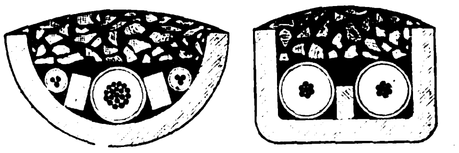
FIG. 4.—ASPHALT TROUGHING.

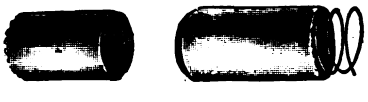
FIG. 5.—ASPHALT CONDUIT.

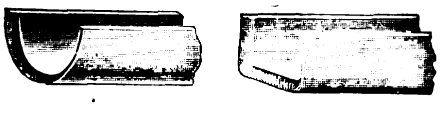
FIG. 6.—SEMI-CIRCULAR AND SQUARE TROUGHING.

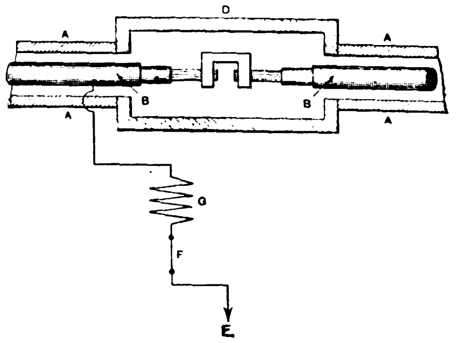

FIG. 7.—DIAGRAM OF CONNECTIONS.

Emergency Brake for Electric Cars—According to the London "Electrical Review" the large number of accidents due to want of sufficient brake power has caused the Board of Trade to refuse to sanction the opening of some lines until more effective brakes are employed. A powerful brake instantly applied to the wheels simply causes them to skid, allowing the car to continue on its course, espe-

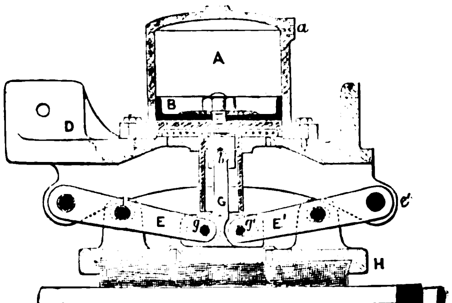

FIG. 8.—EMERGENCY BRAKE.

cially if it is going down hill, and produces flats on the treads of the wheels. It is, therefore, obvious that an emergency brake, to avoid such mishaps, must act upon the track itself, and be entirely independent of the brake on the wheels. Fig. 8 shows a brake which is fitted to the cars of the Oldham and Stockport corporations and which is said to be most effective. It acts directly on the rails and is applied by compressed air, the compressor being driven from one of the axles of the car. An air cylinder, *a*, is carried on a bracket, *d*, attached to truck. The piston, *b*, of the cylinder, is connected by a swinging rod, *g*, to two levers, *e*, *e'*, which have their fulcrums on the bracket at *e* and *e'*. The levers carry the slipper shoe, *h*, on which is fixed a brake block of oak or beech. The brakes are applied by means of a handle placed near the hand brake, and above the handle is a pressure gauge indicating the pressure available for use. Before adopting the brake the Stockport corporation made a test on a car running at a speed of 20 miles an hour, and on a sudden application of these brakes alone, the car is said to have been brought to a standstill within two car-lengths.

Design of Fly-Wheels.—In a paper read before the Institution of Engineers and Shipbuilders of Scotland, and reprinted in several English contemporaries, A. M. Downie discusses the several forms of rim joints in flywheels, and emphasizes the following points regarding their construction as worthy of note. In the flanged and bolted joint, shown by Fig. 9, the bolts should be as near the rim as possible, consistent with getting a deep flange. The bolts should be carefully fitted at each end and cleared in the center, so that the stress on them should be tensile rather than shearing. They should all be initially stressed by screwing up, if possible to the same amount. The accurate machining and fitting of the dowel-plate and cotter joint, shown by Fig. 10, is most important. It should, of course, be so designed that the strength of the cast-iron, cotters and portion of the dowel-plate, in shear, is equal to the strength of the portion of the dowel-plate in tension. The accuracy with which the initial stress in this form of joint can be adjusted is an important feature in its favor. The arrow-headed key joint, shown by Fig. 11, is a shrunk joint, and is open to the objection that the initial stress on the keys due to shrinking-in is a more or less unknown quantity, and the ultimate strength therefore indeterminate. The points to be attended to in its construction are, accurate machining between the cheeks on keys and rim, and provision for clearance at the center, for the same reason as noted in reference to the flanged and bolted joint. The "link and lug" joint, shown by Fig. 12, is also a shrunk one, and subject to the same objection as the arrow-headed bolt joint on that score. If made with the lug projecting, as shown on the illustration, it has the advantage that the section of the rim is not diminished at the joint. The increase of weight, however, which such a form necessitates, is a good reason for removing the position of the joint nearer one arm.

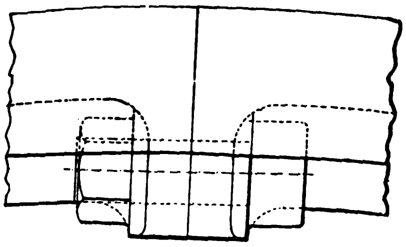
FIG. 9.—FLANGED AND BOLTED JOINT.

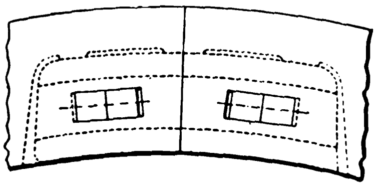
FIG. 10.—DOWEL PLATE AND COTTER JOINT.

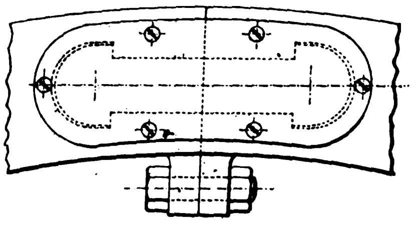
FIG. 11.—ARROW HEADED KEY JOINT.

A good average value for the energy necessary to be stored in flywheels for electric lighting purposes is 2.9 foot-tons per electric horse-power, and in traction plant 4 foot-tons. Cast-iron flywheels should, where practicable, have solid rims, but when jointed, the best form is the "link and lug" type where such can be adopted without inconvenience, and the next best is the dowel-plate and cotter. Flanged and bolted joints should be avoided, and the best place for a joint is near one arm. Solid-rimmed cast-iron flywheels may be run at a peripheral velocity of 100 ft. per second, with the certain knowledge that the "factor of safety" is not under 12, and link-jointed wheels may also be run at that speed, and have a certain factor of safety of 8. A lower factor of safety should not be used, and flange-jointed wheels should not be run above 70 ft. to 75 ft. per second. Built steel wheels may be run up to 130 ft. per second. Arms should be joined to rims with large fillets, and their fixing to the hub should be carefully fitted. The best material of its kind should be used in construction, and homogeneity should be insured as far as practicable by having test bars cast and proved from each segment.

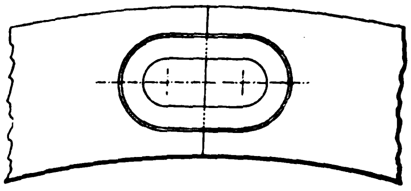
FIG. 12.—LINK AND LUG JOINT.

Intercommunicating Telephone.—The London "Electrician" describes in a recent issue an intercommunicating telephone set, of English make, which is here illustrated by Fig. 13. To call any other office, the user of the instrument takes the combination telephone from its hook, presses down the proper lever, and pushes his bell-push; the replacement of the telephone on the hook automatically replaces the switch lever, and the instrument is again ready for service. The action of the instrument is as follows: Pressing down one of the numbered levers corresponding to the line wanted, causes a projection on the back of the lever to engage an L-shaped bar connected to the speaking set. This bar is slightly raised by a cam gearing when the telephone is replaced on its hook, so that the lever is released and pulled back into its original position by a small helical spring attached to it. Moreover, pressing down the lever rocks a "speaking bar" slightly, so that if the user wishes to speak on different lines in succession he need not replace his instrument; for on switching in the second line the first is automatically disconnected. If conversation is desired with two offices at once it is necessary to depress both levers simultaneously. There is no actual switch-hook, the hooks on which the telephone is placed acting only mechanically. In place of the switch-hook a switch in the handle of the telephone is provided, as in the American Ericsson instrument. The usual wiring connections are required; one wire for each circuit to every instrument, and a common return wire or earth connection.

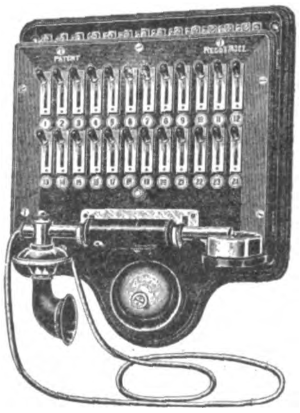
FIG. 13.—INTERCOMMUNICATING TELEPHONE.

Designing Direct-Current Dynamos.—Rankin Kennedy writing on the subject of direct-current dynamo design in the London "Electrical Review," says there is not much mystery about designing machines for sparkless commutation; all that is necessary is to "put enough stuff in the machine," but the stuff must be of the right sort and in the proper place. The e.m.f. given out by a dynamo depends on three factors: Speed, magnetic flux through armature and number of turns or bars in armature winding. Of these, the first is fixed, and the two latter are left to the discretion and skill of the designer. Using Kapp's units (a Kapp unit = 6000 Maxwells), he contends that any proportion of the number of turns in the armature to the magnetic flux through it, which is below the ratio of 1 to 3 is risky in a bipolar machine. In multipolar machines the ratio of the flux under one pole to the number of turns between the centers of two poles, should not be less than 3. Dividing the armature winding into many sections reduces sparking at the commutator somewhat; but to improve on any design having commutator troubles, it is necessary to reduce the armature winding and increase the magnetic flux.

Electrolytic Meter for Direct Current.—The electrolytic meter shown diagrammatically by Fig. 15 has just been brought out by Hans Zadek and described in the "Elektrotechnische Zeitschrift." A lever, *A* A_1, is pivoted at *X*, and carries on its shorter arm a copper plate, *B*, submerged in a solution of a copper salt contained in a copper cup, *D*, which acts as a cathode. A resistance, *R*, is connected in shunt with the instrument. Another resistance, R_1, is connected as shown in series with the instrument. The copper cup, *D*, is connected with the terminal, *Q*, at *Y*; *S* S_1 is a graduated scale beam, the end, *S*, of which moves in front of a point on the upright, *J*. Current enters at the positive terminal, *O*, and divides, the greater part passing through *R* and out, and the other part passing through R_1 to *M*, then through the copper plate, *B*, to *Y*, and out through *Q*. The meter operates as follows: By adjusting W_1 the lever, *A* A_1, is balanced with its end, *S*, opposite the point on *J*. When current passes through the meter, copper is deposited on *D* from the plate, *B*, which, becoming lighter and lighter in weight, permits the pointer, *S*, to fall. When reading the meter the weight, W_1, is pushed toward the left until the point, *S*, is again opposite the point on *J*, and the difference in weight is recorded. When the plate, *B*, becomes too light to permit of balancing the scale, the lower weight, W_2, is pushed toward the left, and the operations carried on as before. The upper scale is graduated in 100 divisions and the lower scale has 10 divisions, so that when 1100 units have passed through, it is necessary to renew the plate, solution and copper cup. The upper weight is adjusted along the scale beam by means of an endless cord passing over four rollers, P_1, P_2, P_3, P_4.

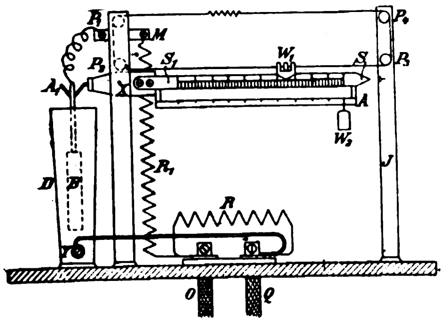

FIG. 15.—ELECTROLYTIC METER.

A Cut-out System for Broken Overhead Wires.—At least one system has already been employed by means of which a section of trolley wire is automatically cut off from the circuit when it breaks, and part of it, therefore, carries no current. This is accomplished by means of an auxiliary wire, brought back from the far end of the section to a cut-out situated at the beginning of the section. An arrangement devised by Siemens & Halske and described in the "Elektrotechnische Rundschau," extends the application of this system to other overhead circuits than trolley wires, employing only one cut-out wire for the whole group of conductors. The method consists, in the case of a two-wire system, of connecting a resistance or battery across each end of the section to be protected, a connection being made between the middle points of these resistances or batteries through the coil of the cut-out, as shown by Fig. 14. This cut-out, *k*, controls contacts in the main circuit. Normally the two ends of the auxiliary wire, *h*, being at the same potential, no current passes through the cut-out; but so soon as one of the main wires is broken, a current passes through the circuit formed by the sound wire, half the resistance at each end, and the cut-out and its wire. The cut-out thereupon acts to break the main circuit. The system, it will be seen, is somewhat similar to that frequently employed on telephonic inter-exchange lines for giving a clearing-out signal automatically so soon as the connecting plug is removed. Similar arrangements can be made in circuits of more than two wires. In the three-phase system, for instance, one end of the cut-out wire would be connected to the neutral point of the generator, as shown by Fig. 16, and the other to the neutral point of a useful three-phase load, or of an idle capacity or inductance.

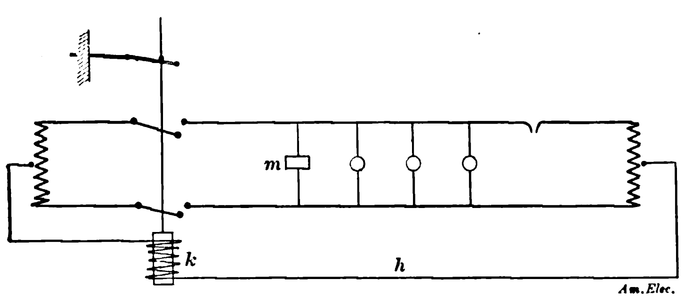

FIG. 14.—CUT-OUT ON TWO-WIRE SYSTEM.

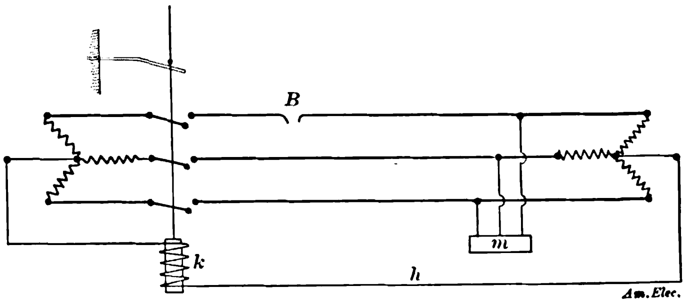

FIG. 16.—CUT-OUT ON THREE-PHASE SYSTEM.

Some Recent Electrical Patents

Neutralizing Line Capacity.—The electrostatic capacity of lines carrying electric currents, particularly underground cables, has proved a serious trouble in alternating-current working. It is this trouble which renders long-distance telephony difficult, and to remedy which the now well-known system of Prof. M. I. Pupin was invented. Another disadvantage of electrostatic capacity is the requirement of a considerable line-charging current in heavy alternating-current work and the imposition of so-called "wattless" currents on the generating plant, thus reducing the proportion of its output available for useful work. A method of correcting this trouble which will strike the reader as being remarkably similar to that of Prof. Pupin has been patented by William M. Mordey, the well-known English engineer. Mr. Mordey's system consists of the use of choking coils connected across the line all at one place, as indicated in Fig. 1, but preferably at a central point of the distribution system. The feature which differentiates this method from Prof. Pupin's is that Mr. Mordey's choking coils are grouped at one point, while Prof. Pupin's are distributed along the line. This difference, while apparently unimportant, renders the Mordey system unavailable for the correction of telephonic troubles, only distributed inductances being effective. For lighting and power work, however, the system is applicable, as it is not necessary to distribute the inductances, the frequency being much lower and the wave length consequently much greater than in telephone practice. Patent No. 686,416.

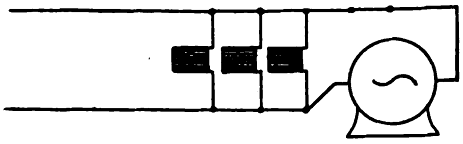

FIG. 1.—GROUPED CHOKING COILS.

Incandescent Lamp.—Judging from the patent records, there is no diminution in the striving to improve the distribution of light from incandescent lamps. One of the latest efforts in this direction is illustrated by Figs. 2 and 3, herewith, which represent a combination of filament and reflector devised by P. A. Gibbons. The illustrations are practically self-explanatory; the filament is made in double spiral shape and surrounds a multi-prismatic reflector. In Fig. 3 this reflector is a straight rod of glass having a star-shaped cross-section, as indicated in the lower small detail sketch between the two lamps. In Fig. 2 the reflector is ellipsoidal in shape and has a cross-section through the maximum transverse diameter like that indicated by the upper star-shaped sketch. Patent No. 681,692.

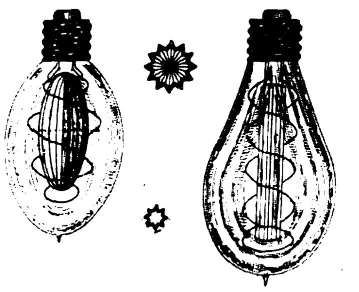

FIG. 2.—INCANDESCENT LAMP.—FIG. 3.

Lead-Zinc Accumulator. —Fig. 5 herewith illustrates a form of lead-zinc storage battery cell which has been patented by Georges d'Infreville. The cell consists of a negative electrode, 8, composed of sheet lead rolled into the form shown by Fig. 4, which is a plan view of this electrode; a positive electrode, 1, of zinc and mercury; and the usual containing jar, 2. Between the zinc and the cover from which it is suspended is a washer, 4, preferably of elastic material, the function of which is to prevent the gases from rising through the central hole and attacking the connections. The lead electrode is preferably of the Planté type.

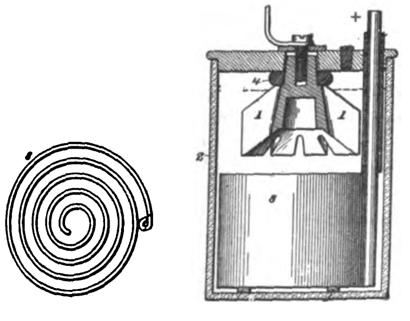

FIG. 4.—LEAD-ZINC ACCUMULATOR.—FIG. 5.

The electrolyte is diluted sulphuric acid, and as the density of the solution is naturally less and less at successively higher levels, and the mercury on the zinc electrode by reason of its weight accumulates at the lower part of the electrode, the density of the solution is greater where the mercury is most plentiful than it is at a higher level where there is less mercury, which condition is naturally favorable to the electrode. During the discharge of the battery, sulphate of zinc is formed, and this having a lower specific gravity than the sulphuric acid solution remains in the upper part of the cell around the zinc electrode, thus contributing to the protection of the zinc from attack by sulphuric acid when the battery is left on open circuit. It was this consideration which led the inventor to arrange the electrodes horizontally instead of vertically. Patent No. 687,885.

Ventilated Dynamo Structure.—It is well known that the output of a completely enclosed dynamo or motor is considerably reduced as compared with the output of the same machine when not entirely enclosed, because of the lack of access for the surrounding air to the interior of the machine. With a view to correcting this condition, W. Langdon-Davies and Alfred Soames have devised the construction indicated by Fig. 6 herewith. This method of construction consists of enclosing each end of the armature by means of a thin shell so as to form two distinct chambers, *E, E,* one at each end. The shaft is hollow at each end for a sufficient distance in toward the center to allow holes, *F, F,* to connect the bore of the shaft with the chamber on that side of the armature. Ventilation is effected by forcing a stream of air in one end of the shaft, the air passing from one chamber to the other through passages in the core and out at the other end of the shaft. Patent No. 686,856.

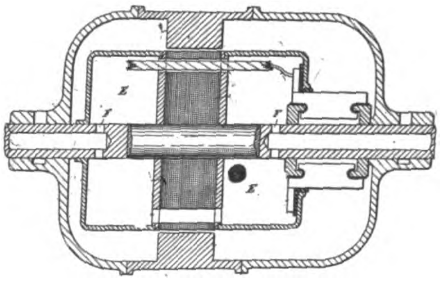

FIG. 6.—VENTILATED DYNAMO STRUCTURE.

System of Motor Control.—The superiority of employing several different impressed voltages for the purpose of obtaining a plurality of speeds from electric motors, as compared with the use of the ordinary adjustable resistance, has long been recognized and several multi-voltage systems are in practical operation. One of the most recent systems of this class is the one illustrated diagrammatically by Fig. 7, which has been patented by William S. Andrews. In this engraving *A* represents the armature of a generator, the winding of which is tapped at three points, the taps being led off through collector rings to a three-phase inductive coil, *E*. From the common center of the three windings of this inductance a wire is led to one of the distributing circuit wires. Two of the circuit wires are connected to the brushes of the generator, as usual, and a fourth circuit wire is connected to a point midway between the two armature circuits of a motor-generator, *F*, the terminals of which machine are connected between one of the main leads from the generator and the lead from the neutral point of the three-phase inductance. The armatures of the motor-generator are wound for different voltages, so that the voltage between the main wires, 3 and 4, is different from the voltage between the wires 1 and 4. The voltage between the wires 1 and 3 is obviously the same as the voltage between the wires 2 and 3, as the wire 3 is fed from the neutral point of the inductance, the potential of which is midway between the potentials of the two generator brushes *B*, and *B*. Assuming that the extreme outside e. m. f. between the wires 1 and 2 is 240 volts, the e. m. f. between 1 and 3 and between 2 and 3 will be 120 volts. Assuming that the right-hand armature of the motor-generator gives 40 volts and the left-hand armature 80 volts, the e. m. f. between the wires 4 and 3 will evidently be 40 volts, while the e. m. f. between 4 and 1 will be 80 volts; consequently, by connecting the motors successively between wires 4 and 3, 4 and 1, 1 and 3, 2 and 4, and 2 and 1, the e. m. f's. impressed upon the motor will be successively 40, 80, 120, 160 and 240 volts. The controller shown diagrammatically at the bottom of the engraving is designed to perform this cycle of connections. Patent No. 687,189.

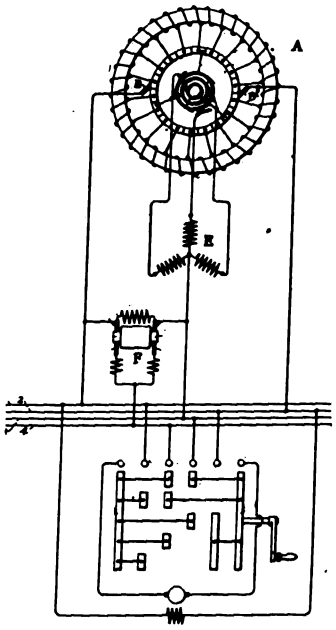

FIG. 7.—SYSTEM OF MOTOR CONTROL.

NOTES.

Railway Material Desired.—We are advised that M. V. Cheesman, Columbus, Ohio, will be in the market shortly for a considerable amount of electric railway construction material, supplies, etc.

The Nernst Lamp for Street Lighting.—It is stated that a number of Nernst lamps have been installed in Farmington, Conn., for street lighting service, and that the new lamp will also be used for this purpose in Unionville, Conn.

The Keswick Transmission Plant.— The new electrical transmission system of the Keswick Electric Power Co., Keswick, Cal., has been put into operation, and power is being transmitted to Redding, Cal., a distance of 29 miles. The generating plant, which is run by water power, is located on Mill Seat Creek, 34 miles from Keswick. The company is preparing to light the town of Keswick, and will also supply power to the smelting plant of the Mountain Copper Company at Keswick and to the Iron Mountain mine, 14 miles beyond. Another extension of 27 miles to Red Bluff is also projected.

Beauties of Government Telegraphy. —A recent press dispatch from London cites the following example of intelligent telegraph service as conducted under government supervision in rural England: "A telegram was sent from Dunwich to Wessleton, Suffolk, villages about two miles apart. It took one and one-half hours in transit. Inquiry showed that it was first telephoned from Dunwich to Southwold, four miles as the crow flies, then telegraphed from there to Lowestoft, 11 miles. Then from Lowestoft, which lies in the extreme north of Suffolk, it was telegraphed to Ipswich, in the south, a distance in a straight line of 38 miles. From there it was retransmitted another 18 miles to Saxmundham, then a few miles more to Dursham, whence it was sent by foot messenger to Wessleton. A boy could have walked the distance in about a third of the time."

Wireless Telegraph Equipment for the Navy —It is reported that the U. S. Navy Department has taken the initial steps toward the adoption of wireless telegraphy as a means of signalling between warships at sea. Admiral Bradford, of the Bureau of Equipment, has asked that the armored cruisers of the Pennsylvania class have their masts and rigging so arranged that the wireless system can be introduced. This will necessitate the lengthening of the masts of the ships and the insulation of the metal rigging by the use of hemp covering. It is intended to get test sets of instruments of the various wireless systems thus far developed, including, of course, the Marconi system. Thus far, however, the Navy Department has not adopted definitely any system, but the special construction for the new ships is regarded as a preliminary to the adoption of a system whenever its practicability is established fully.

Pan-American Diplomas.— The Pan-American Exposition Company is so heavily embarrassed financially that it is unable to meet the expense for diplomas for its exhibitors. There are about 10,000 diplomas to be issued, and the company decided that diplomas costing 82 cents each would be too expensive, and that two kinds of diplomas, one costing 33 cents and another 25 cents each, would have to be issued. Even this expense, which will amount to about $3000, is beyond the company's present means. The natural but humiliating solution of the problem would seem to be the requirement that each exhibitor pay the expense of producing his diploma, but a consideration of this plan develops the dreadful contingency that the exhibitors might not consider the diplomas worth their cost.

The Commercial Aspect of Electrical Transmisson.—According to the "Journal of Electricity, Power and Gas," some figures taken from the balance sheets of the Bay Counties Power Company indicate that the question of financial returns, which is, of course, of prime importance in any industrial enterprise, has been most satisfactorily answered in the case of the company named. The earnings for the past six months were as follows:

	Gross.	Expenses.	Net Earnings.
April, 1901	$13,913.21	$4,466.35	$9,446.86
May, 1901	16,195.76	4,590.86	11,604.90
June, 1901	18,219.78	4,217.11	14,002.67
July, 1901	20,903.46	6,674.15	14,229.31
August, 1901	24,185.70	6,033.51	18,152.19
September, 1901	25,463.52	6,864.59	18,598.93

In addition to the above gross earnings, the company has signed contracts for additional power supply amounting to $15,000 a month, and it is expected that a further additional income of $10,000 a month will be obtained by the sale of the remaining unsold capacity of the existing plant, making a total monthly gross income of over $50,000. It is stated that the operating expenses corresponding to this will not exceed $9000. The monthly fixed charge for interest on mortgage bonds sold October 1 is $13,125, which must, of course, be added to the assumed operating expenses of $9000.

Another Revolutionary Genius. — A correspondent has sent us the following gem, clipped from a Lima (Ohio) daily paper: "Thomas Thompson, residing on East Eureka Street, recently sent to Washington, D. C., the diagrams of an apparatus for propelling street cars, which he invented, intending to have it patented as quickly as possible. The product of his experiment tends to the revolutionizing of street car motive power. He proposes to abolish trolley wires and wheels from which the electrical power is now derived, by constructing trucks beneath the cars in such a manner as to generate the requisite power for moving them by the car wheels passing over specially made rails.

"His idea is to have twelve wheels, the same as now employed under each car. In the center of each rail he would place in small grooves, copper wires. The machinery passing over these the inventor asserts, would generate an electrical current which with the ordinary mechanism of a street car, could be conducted in the dynamo, thus furnishing the cars propelling force. By this scheme power houses, with their attendant expenses, could be obviated. No inconvenience would result in suburban operations. The cost of manipulating the cars would be greatly reduced. Many phases of inconvenience now encountered in operating in cities would be removed. Old plants could be readily remodeled when desired to meet all the requirements of the new arrangement." Beautiful! Beautiful!!

A New Trolley System for New Jersey. —According to a press dispatch printed by the daily papers, U. S. Senator John Kean, Governor F. M. Voorhees, Hamilton F. Kean and Frank Bergen are at the head of a trolley company recently organized in Elizabeth. The company's plans include an entire system connecting Newark, Elizabeth, Plainfield and Perth Amboy with the towns along Staten Island Sound and the Summer resorts along the coast. This makes necessary a bridge across the Raritan River, between Perth Amboy and South Amboy. The Middlesex County freeholders have had plans prepared for a bridge to cost $150,000. They expect the trolley companies to pay part of the cost for the privilege of crossing the river. A trolley line is to be built from Newark to Elizabeth and Plainfield, and another from Elizabeth to Perth Amboy, by way of Rahway and Woodbridge. The third line of the system will extend from Elizabeth to Perth Amboy, along the shore of Staten Island Sound.

Standardization of Direct-Connected Engines and Dynamos.—The American Society of Mechanical Engineers, at its annual meeting held last month, received the final report of the Committee on Standardization of Engines and Dynamos. The report refers only to direct-current dynamos of 25 to 200 kilowatts capacity. The accompanying table summarizes the recommendations of the committee:

The speeds specified were chosen after an investigation of the practice of all the engine and dynamo builders in the country. A variation of 5% above or below the speeds in the table is permissible, and this, the committee states, will cover the practice of all the machines which may be considered as standard at the present time. The figures for shaft diameters and armature bore are intended to apply only to engines that are connected to the dynamos at the side and not to cross-compound engines where the dynamo is between the two cranks.

Concerning the space occupied on the shaft by the dynamo, figures for which are given in the seventh and eighth columns of the table, the committee explains that the practice of manufacturers required provision for two classes of machine, which may be designated as "long" and "short" generators. The maximum difference in length between the two classes is 6 ins., and the minimum difference is 5 ins. In a case where an engine is to be provided for a generator which falls between the "short" class and the "long" class, the excess clearance is to be provided for on the side of the dynamo next to the engine.

Under the heading of "Height of Shaft Above Top of Base" provision is made for two classes of generators, those which are split vertically and those split horizontally. The former have a flat base which rests directly on the flat top of the engine subbase, while the latter have lugs or feet upon which the generator structure rests. In order to arrange so that engine builders' patterns may be reduced to a minimum and still be stock patterns which will fit every style of machine, dimensions for the height of the shaft axis above the top of the sub-base have been made to allow for vertically-split machines, and also, except in the case of 150-kw. and 250-kw. units, to clear the periphery of the yoke-ring of horizontally-split machines. In the case of the 150-kw. and 200-kw. units, the curve of the yoke-ring is allowed for by a curved recess in the top of the sub-base, the radius of which is indicated by *R* in the accompanying drawing.

The allowance of 1/1000 inch for 6-in. and smaller shafts, and 2/1000 inch for 6½-in. and larger shafts, for a pressed fit, is recommended as representing the best existing practice. The bore of the armature spider is to be made the exact size given in the table, the allowance for a pressed fit being made on the shaft.

TABLE OF SIZES, SPEEDS AND STANDARDIZED DIMENSIONS OF RELATED PARTS.

Capacity of Unit, Kilowatts.	Revolutions per Minute.	ARMATURE BORE		DIAMETER OF ENGINE SHAFT AT ARMATURE FIT.		SPACE OCCUPIED ON SHAFT BETWEEN THE LIMIT LINES		*B*, Length of Extension Pieces, Inches.	*C*, Height of Axis of Shaft above Top of Base, Inches.	*R*, Inches.	*D*, Width of Top of Sub-Base. Inches.	KEY (A FEATHER).				HOLDING-DOWN BOLTS	
		Center Crank Engines, Inches.	Side Crank Engines, Inches.	Centre Crank Engines, Inches.	Side Crank Engines, Inches.	Long Class *A*, Inches.	Short Class *A'*, Inches.					Width, Inches.	Thickness, Inches.	Depth in Shaft at Edge, Inches.	Projection above Shaft at Edge, Inches.	Diameter, Inches.	Number.
25	310	4	4½	4 + 1/1000	4½ + 1/1000	30	25	5	23½	Flat.	48	1	¾	⅜	⅜		4
35	300	4	5½	4 + 1/1000	5½ + 1/1000	33	28	5	25	Flat.	54	1	¾	⅜	⅜	1	4
50	290	4½	6½	4½ + 1/1000	6½ + 2/1000	37	31	6	28	Flat.	60	1¼	¾	⅜	⅜	1	4
75	275	5½	7½	5½ + 1/1000	7½ + 2/1000	43	37	6	31	Flat.	66	1½	1	½	½	1¼	4
100	260	6	8½	6 + 1/1000	8½ + 2/1000	48	42	6	34	Flat.	72	1½	1	½	½	1¼	4
150	225	7	10	7 + 2/1000	10 + 2/1000	51	45	6	37¾	41¼	84	1¾	1¼	⅝	⅝	1¼	4
200	200	8	11	8 + 2/1000	11 + 2/1000	54	48	6	42¾	47½	96	2	1¼	⅝	⅝	1½	4

NOTE 1.—Five per cent. variation of speed permissible above and below speeds in table.
NOTE 2.—Distance from center of shaft to top of base of outboard bearing may be less than *C* (to suit engine builder), though not less than possible outside radius of armature.

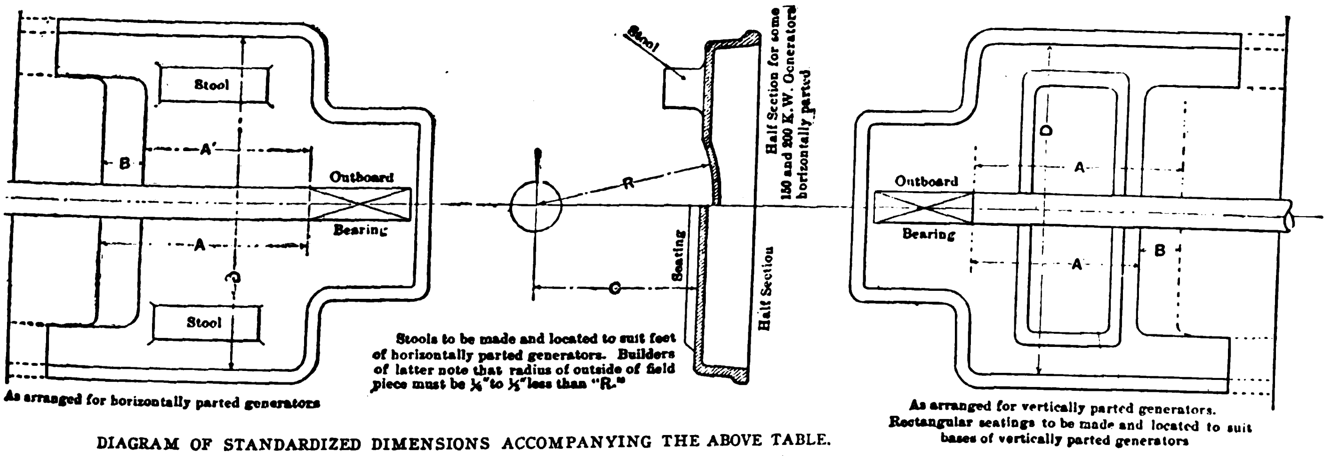
Stool
B
A'
Outboard
Bearing
A
C
Stool
As arranged for horizontally parted generators
Stool
R
C
Seating
Half Section for some 150 and 200 K.W. Generators horizontally parted
Half Section
Stools to be made and located to suit feet of horizontally parted generators. Builders of latter note that radius of outside of field piece must be ¼" to ½" less than "R."
D
A
Outboard
Bearing
A
B
As arranged for vertically parted generators.
Rectangular seatings to be made and located to suit bases of vertically parted generators

DIAGRAM OF STANDARDIZED DIMENSIONS ACCOMPANYING THE ABOVE TABLE.

The committee recommended that the standard overload rating of a direct-current unit should not in any case exceed 25% of the rated full load, and that under such overload the economy of the unit should not be expected to be as high as when operated at rated load. If, under peculiar conditions, a higher overload capacity is demanded, it must be understood that this is a special case not covered by the specifications for standard machines.

It is recommended that the brush-holder rigging be supported upon the generator frame, as is the practice with all of the representative dynamo builders. Holding-down bolts, shaft keys for securing the generator hub to the shaft, and outboard bearings, should be furnished by the engine builders. While the table gives the other dimensions of keys or feathers, it was thought best to leave the determination of the length of key for settlement by the builder in each individual case, as the opinions on this subject differ so widely. It was recommended that the keys be made straight and used as feathers; they should therefore fit accurately on the edges and not on the top.

In conclusion, the report states that in the course of the investigations of the committee attention was called to a number of points which, from their nature, are not exactly in the same category as those on which recommendations are made, yet are of such importance that they are offered as suggestions for consideration by members of the society, with a view to their adoption if considered sufficiently meritorious. The points are as follows:

With regard to pressing armature on shaft, usually the contract definitely provides by whom this is to be done, but it is suggested that if there is no such provision in the contract, it should be understood that the engine and generator builders shall agree who is to do this work, so as to avoid any dispute when the separate portions of the unit are delivered on the premises.

For convenience in operation and for the information of engine and generator builders, it is suggested that for units up to 75 kilowatts, inclusive, the floor line should come at the bottom of the sub-base; and for units 100 kilowatts to 200 kilowatts, inclusive, the floor line should be 1 inch below the rough top of the sub-base.

In view of the fact that in some cases the distance between bearing and commutator is very small, it is well for engine builders to bear in mind that provision should be made to prevent oil from the bearing getting on the commutator.

Some generator builders have asked that the end of the shaft be drilled and tapped to facilitate, if necessary, the removal or placing of the armature on the shaft at the place of erection; it is suggested that this be done.

In some cases generator builders require special nuts, bolts or fixtures for attaching generators to the shaft. Under these conditions it is suggested that the generator builders should furnish all attachments to their apparatus that are not already specified in the report.

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Greeting.

Happy New Year! And there appears to be every reason to believe that this New Year is fraught to an unusual degree with happiness for the electrical fraternity, so far as prosperity is a measure of happiness. Judging from all reports, the electrical and kindred industries were never in so satisfactory a condition as now, not excepting last January even, when everything was in a state of enthusiastic buoyancy. The present condition of business appears to be more stable than a year ago, and nearly if not quite so optimistic. We sincerely trust that every one of our readers is sharing the smiles of fortune, and we extend hearty wishes to them all for a successful year, crowned with contentment.

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In Explanation.

Readers who may experience a painful sensation in the region of the optic nerve upon the perusal of some of the pages of this issue need have no apprehension of impending strabismus; nor is the sensation necessarily due to after-effects of Christmas festivities—it's the type! The composing room in which the type-setting for this paper is done was partly destroyed by fire on December 22, and as a consequence part of the text of the present number is in type of one style and part in another. Where the two styles meet on a page the effect is not pleasant to the eye. In order to minimize this effect as much as possible of the matter that was in type before the fire has been reset, but the time was too short to do this throughout. As it is, the fire has caused the present number to be issued several days late by reason of the destruction of some engravings and type, together with considerable manuscript that had not been put in type, and the entailment of other delays in the preparation of both reading matter and advertisements.

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The Modern Isolated Plant.

During the past five years there has been a remarkable transformation in the character of the commercially isolated plant. From a small dynamo, located in any spare corner and belted to a convenient line shaft, or driven by a little slide-valve engine, the generating plant has developed into direct-connected generators and engines of hundreds, and frequently thousands, of aggregate horse-power, located in a large room especially prepared for them. The auxiliary appliances have grown from a rheostat, a double-pole fused switch and a voltmeter into an array of main and feeder switches, circuit-breakers, indicating and recording measuring instruments, and possibly a storage battery and booster equipment, as in the case of the plant which forms the subject of our leading article. The equipment of one of a surprisingly large number of isolated plants would be ample for the needs of a town central station of respectable size. It is probable that the evolution of the modern isolated plant, excepting factory plants, is due more to the evolution of the modern office building than to any other one cause. The two have practically "grown up together."

The history of the factory plant is somewhat different. In early days the factory isolated plant was practically a duplicate of that of any other building. The lighting equipment was gradually supplemented by the addition of a motor here and there, to drive a machine located where it was not practical to transmit power by belt or shaft. The number of such machines increased as the industrial plant grew, until a point was reached where uniform methods became obviously urgent. By that time the motor, hitherto taken largely on faith, had demonstrated its inestimable advantages, and the logical result was the supercession of main belts and shafting by generators and motors. After a number of industrial plants had undergone this process of evolution, others in which there had been no occasion for the intermittent installation of motors took pattern and threw out the shafting and belt equipment bodily at the first opportunity. Thus it came about that isolated plant practice grew to a scale and character, in factory work, that render it difficult to properly classify the equipment of some of the mammoth establishments, such as Armour's, Swift's and the Deering Harvester Works, in all of which central station methods are followed closely. In fact, the only feature that differentiates these plants with their polyphase equipments, central power houses, etc., from a modern central station is the fact that there is only one consumer—the owner—instead of a plurality.

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The Symbol for Current Strength.

For the past five years the letter "C" has been used throughout the pages of this paper as the symbol for current strength, notwithstanding the adoption of the letter "I" for that purpose by the American Institute of Electrical Engineers and its consequent use by all individual authorities in this country. This policy was not due to lack of progressiveness or to any disinclination to recognize the recommendation of the 1893 International Electrical Congress, on the strength of which the change from "C" to "I" was made by others than ourselves. The reason for adhering to the old symbol so long was in order to avoid possible confusion on the part of any readers who were accustomed to use it, and whose range of reading had not been such as to familiarize them with the use of the new symbol; in all practical books in print until recently, the symbol "C" appeared. The status of affairs is different now; the books in which the old symbol was used have been largely superseded by new editions or new works in which "I" is used exclusively. Consequently, the average reader of practical technical literature now-a-days will find current strength represented by "C" as rarely as he formerly found "I" used for that purpose, and our further continuance of the use of "C" would tend to the very confusion to avoid which its use has been hitherto observed. Beginning with the present issue, therefore, current strength will be represented in these pages by the letter "I," and the letter "C" will be used to represent static capacity, in conformity with the nomenclature now universally employed by leading writers.

Motive Power for Pumps.

As intimated on another page in the thoroughly practical article on the operation of feed pumps, the inexplicable prejudice against electrically-driven auxiliaries which has existed in some quarters is gradually but surely being defeated by the actual performance of such apparatus. One of the efforts at adverse argument that has been made is to the effect that the speed of electrically-driven pumps cannot be graduated because regulating resistance boxes burn out after a short period of service. The absurdity of such a claim is, of course, obvious to electrical engineers, but it was successfully urged in at least two distinct cases within our knowledge a little over a year ago. It is unnecessary to present here any argument concerning the practicability of motor-regulating rheostats; they are in use by the thousand. It may be well, however, to point out that the whole matter resolves into a question of relative expense and flexibility of operation.

A motor-driven pump is considerably more expensive to install than an ordinary steam pump; moreover, it is useless when the electrical generating machinery is shut down. It follows, therefore, that unless a motor-driven pump can save sufficient fuel and repairs to pay the interest on the difference in plant cost—including, if necessary, additional engine and generator output capacity, or else adding a fair sum to represent the value of the power consumed by the pump—it is not worth consideration. It is also evident, irrespective of costs, that electrically-driven pumps cannot be used exclusively in plants where the boiler equipment is operated through a much greater proportion of the day and night than is the electrical generating equipment; in other words, unless the operating period of the pumps corresponds approximately to that of some one of the generators, motor-driven pumps are impractical. Thus, in isolated plants where steam for heating is taken from the high pressure boilers and the electrical equipment is shut down during the day, the steam-driven pump will generally be preferable; while in the case of a plant in which electrical service is maintained all day and part of the night, as where electric elevators are operated, it becomes purely a matter of comparative operating cost as to which form of pump shall be used.

Considering, as an illustration of the last-mentioned case, an isolated or other plant in which the average economy of the engine and dynamo is 0.025 electrical horse-power-hour per pound of steam, the economy of a steam pump of the corresponding class and size will be not far from 0.01 horse-power-hour per pound of steam. An electric motor of the size required for such a pump can be had with an average efficiency of 70 per cent or over, so that the motor-driven pump would show an economy of 0.175 horse-power-hour per pound of steam delivered to the main engine, on the foregoing assumptions, all of which are quite reasonable. Reversing the basis of rating, the steam pump will require 100 pounds of steam per horse-power-hour as compared with 57 pounds for the motor-driven pump.

Let us assume that the pump works at the rate of 3 horse-power, and that the cost of fuel to produce 1000 pounds of steam is 14 cents; then the saving in fuel effected by the use of the motor-driven pump would be about 1.8 cents an hour. If it ran 8 hours out of each 24, the saving per year of 313 days would be $45, which would give the motor-driven pump an excess in value over the steam-driven pump of $750! This appears preposterous, but we think that the figures assumed are very conservative. All operating engineers with whom we have discussed the subject, agree that 125 to 150 pounds of steam per horse-power-hour is as good as can be expected from a duplex steam pump; the efficiency assumed for the motor is realized in every-day practice, and the cost of fuel per unit of steam production is put at a figure that many plant owners would like to realize. Failure to realize it increases the showing in favor of the motor. No account of repairs has been taken in the foregoing comparison; it is entirely fair to the steam pump to assume equality in this respect.

A motor for pump driving should not be the simple shunt-wound machine used for standard service. The use of this class of motor involves an unnecessary degree of loss in the regulating apparatus. Taking into consideration the fact that a pump must frequently run at quarter and half load, the motor should be a compound-wound double-commutator machine. Series field commutation could supply two speeds for each combination of armature connections, giving the outfit four available speeds, at all of which the efficiency could be made fairly high without involving prohibitive manufacturing cost.

Incandescent Lamp Testing for Small Plants.

One of the disadvantages under which an isolated plant or small central station labors is the lack of facilities for testing the quality of incandescent lamps. It has now come to be the general practice of large central stations to test samples from every barrel of lamps received, and if the lamps tested do not come up to the standard the shipment is rejected. This is a practice which is welcomed by conscientious lamp makers who wish their product to go out on its merits. In the small plant, however, there is no opportunity to do such testing, unless more apparatus and time can be devoted to it than is usually available.

Lamp tests, to be of any value, must include a life test at rated voltage, and this voltage must be kept exactly at the figure determined upon at all times. This in itself is not easy to do in a small plant, where there is considerable fluctuation of the circuit e.m.f. near the generator room, which is usually the only place there is space available for testing. The test for candle-power and power consumption in watts is more easily made, but even for this some experience in the use of a photometer and highly accurate measuring instruments is necessary in order to obtain results of any value.

In view of the desirability of such tests and the difficulty of making them in small plants, it has been suggested that a number of isolated plants or small central stations, join together or co-operate in some way so as to have lamp testing done by some one company of the group, or by an engineer or bureau appointed to do the work. The expense to each plant would then be considerably less than if the attempt were made to do the testing individually.

CONSTRUCTION OF A DEMAGNETIZER.

BY S. M. KINTNER.

This article is intended chiefly for the handy central station man of the small city, who goes by the various titles of electrician, lineman, wireman, etc. It is for the man who looks after everything of an electrical nature in his town, from the alternators at the station to the door bells of the citizens. There is no objection, however, to others who may be interested in such a device reading what follows.

All jewelers should include in their stock of tools a demagnetizing device. At present the majority of those who have any such device are provided with a permanent magnet in the form of a horseshoe, and to demagnetize a watch it is suspended by a twisted string between the poles of the magnet and as the watch revolves rapidly it is slowly withdrawn from the magnetic field. The whirling motion, of course, changes the direction of magnetization, and by drawing the watch farther from the magnet the strength of field is gradually reduced and the intensity of magnetization oscillates between values first in one direction then in another, but continually decreasing in intensity, so that when the watch is entirely removed from the field of the permanent magnet it should have no magnetization.

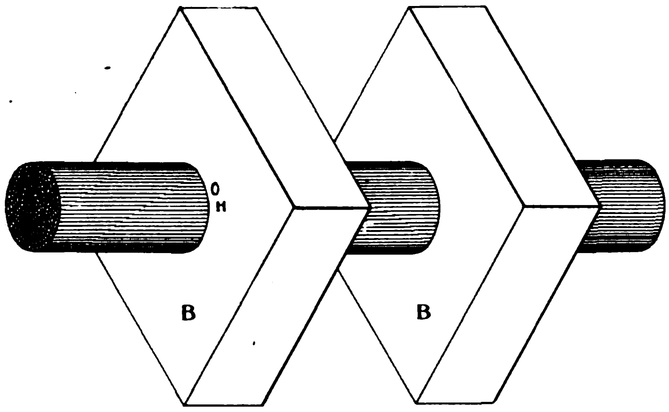

FIG. I.—DEMAGNETIZER.

This device would be all right, aside from the inconvenience of manipulation, were it not for the weakness of its field; a watch badly magnetized may be so strong as to resist the demagnetizing efforts of this form of instrument. The remedy for such a trouble is almost self-evident—a stronger field must be found in which to spin the suffering watch. As a matter of fact, it is immaterial whether the watch changes direction with regard to the field, or the field changes its direction, the watch remaining stationary.

The demagnetizer described in this article is dependent upon the latter principle, and is designed for use on an alternating-current circuit. The demagnetizer consists of a bundle of iron wires, around which a coil of insulated copper magnet wire is wound. The terminals of the copper coil are attached to a lamp socket, by an ordinary attachment plug, and the alternating current going through the coil magnetizes the bundle of iron wires first in one direction and then in the reverse direction, so that to demagnetize any small article like a watch, it is only necessary to hold it near one end of the iron core for an instant and then slowly draw it away, as the magnetic field from the iron core is rapidly changing in direction, and that is equivalent to the whirling motion given the watch in the other method.

In order that it shall be possible to attach this coil to the lighting circuit without blowing the fuses in the cut-outs, it will be necessary to so design the coil and core that the current that will pass on connecting it will not be greater than the regular lamp current. The current that passes will depend on the voltage of the circuit, the number of alternations of the current, the size of the iron core, the number of turns of copper wire and slightly upon the size of that wire. A formula that gives the approximate relations between these quantities is the following:

$$\frac{100{,}000 \times V}{0.7 \times S \times A} = T,$$

where *T* is the number of turns of copper wire; *V* is the voltage of the circuit to which the coil is attached; *S* is the apparent cross-section of the core in square inches, and *A* is the frequency of the current in alternations per minute. As the round iron wire, when clamped in a bundle, fills about 70 per cent of the cross-sectional space occupied by the core, the constant 0.7 is included in the denominator. The number of alternations per minute, represented by *A*, can be determined by multiplying the number of revolutions of the alternator supplying the power by the number of its field magnet poles. It will be noticed that the formula contains two quantities that are unknown, the number of turns of wire and the cross-sectional area of the core. The other factors will be determined by the conditions existing at each particular place, where the voltage will be a fixed quantity, and the same is true of the alternations, within very close limits. The two unknowns are determined by assuming a particular value for one and solving for the other. Generally it will be found best to assume the value of *S* and solve for *T*.

Assume, for example, a 50-volt circuit and 16,000 alternations per minute as the two quantities fixed by the existing system. For *S*, assume .7854 square inch, which is the gross cross-section of a bundle of iron wires 1 inch in diameter. On substituting these values in the above formula, we get:

$$T = \frac{50 \times 100{,}000}{.7 \times .7854 \times 16{,}000} = 589.6.$$

This shows that 590 turns of wire are needed to magnetize the core properly and to keep down the current in the coil, under the assumed conditions. As the resistance of the coil is so small, compared with the reactance, any convenient size magnet wire larger than No. 22 B. & S. gauge will be found suitable.

The iron core should be from 6 to 8 inches in length and built up of pieces of soft iron wire, about No. 18 gauge, which have been either varnished or thoroughly rusted. Varnishing is preferable when possible; otherwise the wires may be rusted by dipping them in salt water, or a sal ammoniac solution, and then allowing them to dry in the air.

A simple and effective way of constructing the device is illustrated in the accompanying sketch. The core is shown threaded through holes in two wooden blocks, *B B*, which are spaced apart the proper distance to allow for the winding between them. This distance will generally be found to be about 2 inches. That part of the core between the blocks should be carefully covered with tape, so as to thoroughly insulate the coil from the core. The coil is wound on over this taped surface, the inner connection being made through a small hole in one of the blocks, shown in the sketch at *H*, where a wire terminal is brought out. The required number of turns having been put on, a variation of 10 or 15 turns will not make much difference, and the outer layer of wire can be made complete; the end of the wire may be fastened by a staple tacked in the block, or may be held under a wrapping of tape. Some provision should be made for keeping the two blocks at the proper distance apart after the windings have been put in place; one convenient way is to nail two strips of wood from one to the other. The rest of the construction can be made as seems best, but care should be taken not to include any large pieces of metal in the enclosing case; the case should be made of wood. This device will be found inexpensive and easy of construction, yet very effective, and with it the worst cases of magnetized watches are readily remedied.

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The Northwestern Electrical Association.—The tenth annual convention of the Northwestern Electrical Association will be held at Milwaukee, Wis., on Jan. 15, 1902. Reports and papers on subjects of special interest to central station men will be read and discussed.

AMERICAN METER PRACTICE.

BY LYMAN C. REED.

DIRECT-CURRENT INSTRUMENTS AND MEASUREMENTS.

The measurement of any form of transmitted energy is always attended by a diminution of the energy transmitted; in other words, the amount consumed in the measuring device. Hence all instruments that measure transmitted energy are shunt instruments, the power shunted or diverted from the transmission being usually a very small fraction of the total power. We may class all such devices as shunt dynamometers, to distinguish them from absorption dynamometers, which usually translate the energy to be measured into heat or mechanical work and destroy its original properties. The measurement of electrical energy which is transmitted is accomplished by means of shunt dynamometers. Its translation into useful commercial forms is accomplished by absorption dynamometers of various classes, such as motors and incandescent lamps.

For the sake of analysis the flow of electrical energy is usually considered by treating its two components, quantity and intensity, as individual entities, and instruments are constructed which will measure each separately as well as the product of the two. In commercial circuits the voltage or intensity usually remains constant, in which case a measurement of the power flowing in a circuit may be obtained by the recording of the variable quantity of current in amperes and multiplying by the known voltage. If the amperes remain constant, and the voltage varies, a record can be obtained of the power flowing by recording the variable voltage and multiplying by the known amperes of the circuit. If both the voltage and amperage of the circuit are variable their product gives the power flowing, which, for convenience, is usually indicated by one instrument, called a wattmeter.

In the first class of instrument, the ammeter, the loss in energy due to its insertion in the circuit is directly proportional to the current flowing. The voltmeter, if on a constant-potential circuit, has a constant energy consumption; the wattmeter has a constant energy consumption in its potential circuit, multiplied by a variable energy loss in the series circuit, proportional to the current flowing.

From the foregoing, the deduction follows that on constant-potential circuits of known intensity the measurement of the energy passing is the most efficiently carried out by an ammeter; on circuits of constant and known amperage, with variable voltage, by a voltmeter; and where both current and voltage are variable, by a wattmeter. These general statements hold true for the measurement of the power in a direct-current circuit, or a non-inductive alternating circuit, but must be modified for inductive alternating circuits containing reactance and capacity, the effects of which will be brought out in a later article.

The various classes of electrical energy to be measured commercially resolve themselves into direct current as distributed by two and three-wire systems, and alternating current, distributed by single and multiphase systems. Direct current, distributed by means of a five-wire system, is also used to some extent, but as the principles involved in its measurement are identical with those of the three-wire system, the five-wire system will not be considered separately.

Two-wire direct-current systems are usually confined to 500 volts, and arc circuits. The three-wire system is the well-known Edison system, the local distribution of which may be either two or three-wire. The amperes flowing in a simple two-wire circuit, with a load at *C*, Fig. 1, are the same in every part of the circuit. An ammeter placed at *A* indicates the same as if placed at *B*, but the energy in the circuit decreases as the distance from *D* increases, becoming less as *C* is approached, and is inversely proportional in a circuit of uniform resistance to the distance from *D*. Hence the mean power in the circuit would be found at some point between *D* and *C*. As the meter, in commercial practice, is placed at the entrance of the service into a building, the consumer usually pays for about 1 per cent more energy than he actually receives at his translating device..

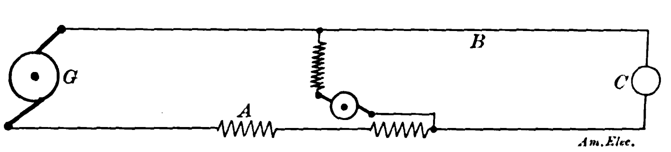

FIG. I.—TWO-WIRE CIRCUIT.

Should the meter be a recording ammeter, one leg of the circuit only passes through the instrument; if a wattmeter is used, the other leg of the circuit may be brought into the meter to enable the potential coils of the instrument to be energized. In a recording wattmeter the product of the magnetizations set up by the series and shunt field coils must exert a resultant torque on some movable member of the meter which will cause it to move so as to record *n* units of energy in *n* units of time.

The movable members of a recording instrument have, unfortunately, an appreciable amount of friction, which introduces an inertia factor operating as a counter torque to the product of the energy torque by a function of time. This friction of the moving parts is small, and at full load of the meter the ratio between the counter torque due to friction and the energy torque is negligible. As the load decreases the ratio between the counter frictional torque and the energy torque approaches unity; in other words, there is a certain point in every recording instrument where the energy torque and frictional torque are equal. When this point is reached the instrument remains at rest.

The counter frictional torque varies in different instruments of the same and different makes, ranging from a fraction of 1 per cent to 3 or 4 per cent of full-load energy torque, the large losses often being due to causes arising in service. For this reason it is customary in commercial recording instruments to compensate for this friction by giving the torque an additional per cent of full-load value, which compensates through all ranges of load for the initial friction of the meter. Theoretically, this is a very pretty way of accomplishing the result, but exactions of service introduce frictions which this compensation does not entirely eliminate.

The power passing in a three-wire circuit is usually measured by metering the two outside legs, although equally good results can be obtained by metering one outside leg and the neutral conductor. In the three-wire circuit, Fig. 2, let *A B* and *D C* be the outside legs and *E* the neutral conductor, and *b* and *c* translating devices. When the currents in *A B* and *D C* are equal, no current flows in *E*; when they are unequal, *E* carries the difference, positive or negative. The energy flowing on each side of the system can be measured by two two-wire meters, or one three-wire meter; in either case the series coils carry the varying amperes of each side of the system, while the shunt field coils are energized proportionately to the voltage of the system.

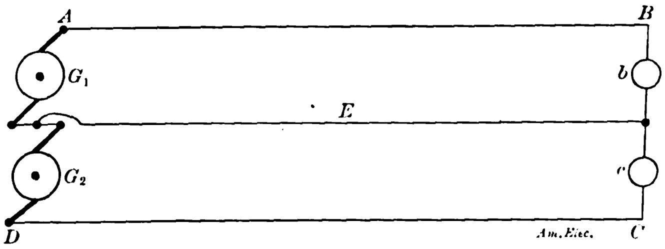

FIG. 2.—THREE-WIRE CIRCUIT.

If two two-wire meters are used, the same connections are made as in a two-wire system. If a three-wire meter is used, the plane of magnetization of the two series fields coincide to form a resultant plane equal to the sum of the two magnetizations and proportional to the current flowing in both sides of the system. The torque formed by the product of this resultant field with the field set up by the potential circuit operates the meter in such a manner as to record the total energy passing in the three-wire circuit.

A form of meter which is not manufactured commercially, so far as the author is aware, can be constructed to measure the total energy flowing in a three-wire circuit by placing one series coil of an ordinary three-wire meter in one outside leg of the circuit and a coil of half the number of turns in series with the neutral; the power registered is multiplied by 2. To illustrate, suppose *A B*, Fig. 2, to carry 50 amperes, positive, and *D C* 25 amperes, negative, then the neutral *E* carries 25 amperes, negative. As the neutral field coil has half the number of turns, the sum of the magnetization of the series fields is equal in effect to a positive current flowing of 37.5 amperes. Twice this amount is 75 amperes, or the same as the series fields of the ordinary three-wire meter would carry in the example given.

The I^2R losses in the fields of a meter at full load are an appreciable amount, but at light loads are not of much consequence, hence in the form of meter just mentioned, used on a properly-balanced three-wire service, the I^2R losses would be halved, as the neutral would carry no current. On unbalanced loads the loss in this form of meter would be reduced by some quantity varying between the limits of ½ and ¼, so that an average saving in I^2R losses in the field coils for any meter would be 12½ per cent. In reality this would be much larger, as serious unbalancing would scarcely take place except at light loads, when the I^2R losses are negligible.

The shunt field coil, where a single meter is employed, can be fed from across the outside or between the neutral and one outside. In either arrangement, unless the voltage is equal on both sides of the system, an error is introduced into the record proportional to the difference of voltage existing. To obtain a true record, if the voltage is unequal, it is necessary to employ two two-wire meters or a three-wire meter having two armatures, fed respectively from each side of the system. The latter combination amounts to the combining of two meters under one cover, resulting in a clumsy and expensive device. In commercial practice the voltage on each side of a three-wire distributing system is usually maintained about equal, the error of the differences occurring supposedly balances, so that it is the usual practice to meter with a three-wire meter, with the shunt field coils fed between the two outsides or between the outside and neutral.

In all meters where the function of time becomes an increment of the speed of the recording device it is customary to provide some form of brake, which increases in power in direct proportion to the torque exerted on the moving member. This brake may be of various constructions, but the usual form is in the shape of a conducting non-magnetic metallic disc revolving between the poles of the permanent magnet. The eddy currents generated in the disc, by their reaction on the permanent magnetic field exert a resistance to movement which varies in amount proportionately to the speed or the torque exerted by the moving member to which the disc is fixed. Hence, the power necessary to generate the eddy currents becomes proportional to the torque exerted on the moving member or the watts passing in the circuit. Other forms of brakes are employed, such as fans and liquid brakes, but these have given place in the latest types of meters to the now universal magnetic brake.

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CALORIMETRY.

THE THROTTLING CALORIMETER.

BY CHAS. L. HUBBARD.

If the percentage of moisture in steam is less than 3 per cent the throttling calorimeter is convenient to use, and gives very accurate results. The accompanying illustration shows the general arrangement. Steam from the main steam pipe, *S*, enters the chamber, *M*, of the calorimeter through a ½-in. pipe, and is throttled by an orifice at *H*, which is about 1/16 in. in diameter. The throttling of the steam causes it to superheat, the amount of superheat depending upon the amount of moisture in the steam to be tested. If the steam contains considerable moisture there will eb no superheating, and the calorimeter will not give reliable results.

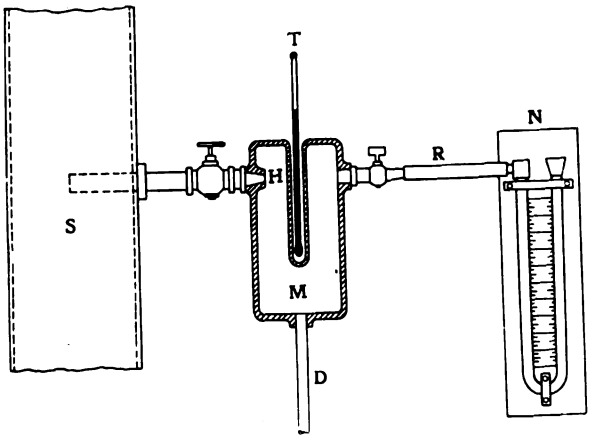

FIG. 1.—THROTTLING CALORIMETER.

The temperature in the calorimeter is indicated by the thermometer, *T*, which is immersed in oil, and the pressure is shown by the manometer, *N*. Sometimes a pressure gauge is used instead of the manometer. Connections between the calorimeter and manometer may be made by means of a piece of rubber tubing, as indicated at *R*, and the chamber, *M*, is drained by means of the pipe, *D*, which is, of course, provided with a valve. Besides the temperature in the calorimeter and the pressure at *N*, the pressure in the supply pipe, *S*, must be noted.

By the use of the valves in the admission and exhaust pipes connected with the chamber, *M*, any pressure desired may be maintained within it. The object of this operation is to admit the heat due to high-pressure steam into a vessel filled with steam at a lower pressure. The excess of heat is used first in evaporating the moisture in the entering steam, and second, if there is any heat remaining, in raising the temperature in the chamber, *M*, above that due to its pressure; that is, superheating the steam within it. The equation for the use of the throttling calorimeter is obtained as follows:

The heat in 1 lb. of high-pressure dry steam, before reaching the calorimeter, is expressed by the equation

$$xL + h = H_1 \text{..........(1)}$$

in which x = the quality of the steam, *i. e.*, the proportion that is absolutely dry;
L = latent heat of evaporation, at the supply pressure;
h = heat in the water, at the same temperature.

After reaching the chamber, *M*, the heat in the steam is that due to its reduced pressure plus that due to superheat. This is given by the expression,

$$H_c + 0.48\,(T_1 - T_c),$$

in which H_c = total heat in a pound of dry steam at calorimeter pressure;
T_1 = temperature indicated by the calorimeter thermometer;
T_c = temperature of ordinary dry steam at the calorimeter pressure.

As no heat is imparted from any external source, the total heat units contained by a pound of the steam in the calorimeter after superheating will be the same as before it entered. Consequently, the foregoing expression may be placed equal to either side of equation (1) thus:

$$H_c + 0.48\,(T_1 - T_c) = xL + h;$$

and this equation transposed to solve for x, becomes

$$x = \left\{H_c - h + 0.48\,(T_1 - T_c)\right\} + L \text{..(2)}$$

which is the working formula for this type of calorimeter.

The following example may make the application clearer: Suppose that the gauge pressure in the main steam pipe is 80 lbs., and that in the calorimeter is 8 lbs.; suppose the atmospheric pressure, as deduced from the barometer reading, is 14 lbs.; the thermometer in the calorimeter registers 273.7°. What is the quality of the steam? From the data just given, and by use of a steam table, we have:

Absolute pressure of entering steam = 94 lbs.;

Absolute pressure of steam in calorimeter = 22 lbs.;

$H_c = 1153$;
$h = 294.4$;
$T_1 = 273.7$;
$T_c = 233.$;
$L = 886.1$.

Substituting these values in equation (2) we have

$$x = \left\{1153 - 294.4 + 0.48\,(273.7 - 233)\right\} + 886.1 = 0.991, \text{ or } 99.1 \text{ per cent.}$$

It is customary to pass only a small part of the total steam supply through the calorimeter, so it becomes necessary that this sample shall fairly represent the entire quantity. Experiments have shown that the quality of steam varies greatly in different parts of the pipe. Steam drawn from near the wall is likely to contain more than an average amount of moisture, and that from the center to contain less. The better method for obtaining a sample is to use a long-threaded nipple in which a series of holes have been drilled, and screw it into the pipe so that it shall extend about three-fourths the distance across it, as indicated in Fig. 2. If a tap pipe with an open end is used, it should not project into the steam pipe more than about one-fourth the internal diameter of the latter.

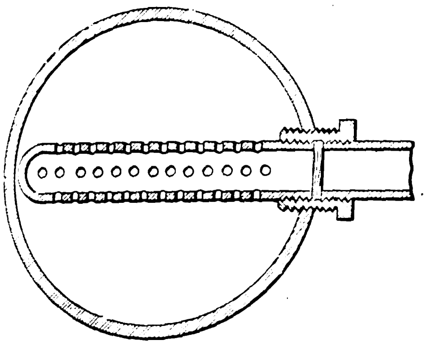

FIG. 2.—NIPPLE FOR OBTAINING A UNIFORM SAMPLE OF STEAM.

◆

FREEING THE NIAGARA CANAL RACES FROM ICE.

BY ARTHUR B. WEEKS.

The successful operation of the Niagara Falls Power Company's plant in winter is a task requiring constant vigilance. The racks in the canal must be early removed, lest their openings freeze over and thus cut off the water supply from the turbines. The ice must then be looked after in another manner, very little trouble occurring outside thereafter. At times, large quantities of ice accumulate in the forebay within the power house at the inlet gate, shown in Fig. 1. A force of men is put into service at once to remove the ice. Long poles, having sieves at one end upon an iron framework secured at right angles to the pole, are used. A rope is attached to the lower end, in order that two men may easily handle the larger pieces. The distance down to the water is ordinarily from 12 to 14 ft.

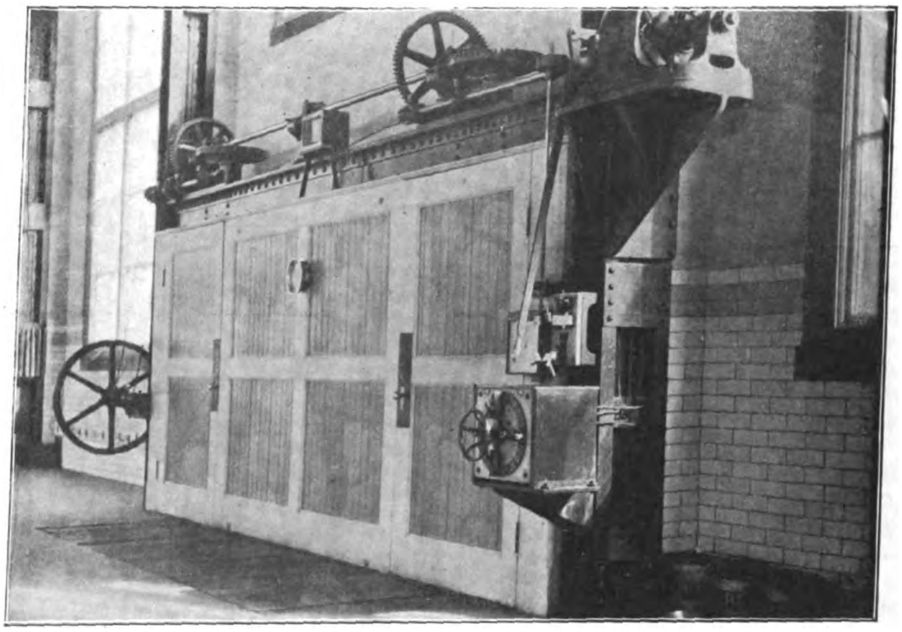

FIG. 1.—INLET GATE IN POWER HOUSE.

As the great quantities of ice are removed from the forebays and thrown outside, the large steam crane, shown in Fig. 2, loads it into a flat car to be hauled away. This crane runs on a track of standard gauge laid in hard cement. At the inlet are gauges to indicate the head of the water, averaging probably 134 ft. although the direction of the wind frequently causes the depth to vary 2 or 3 ft. The instrument shown at the top of the inlet doors in Fig. 3 registers continuously upon a chart for a period of one week; Fig. 4 shows the instrument alone. The motor shown in Fig. 3 is for the purpose of opening and closing the inlet gate, which it does through the medium of gears that drive large square-thread screws fitted into the heavy iron gate. Should anything prevent this apparatus from working, the hand-power wheel at the other side of the inlet can be used; the energy of several men is required to manipulate it.

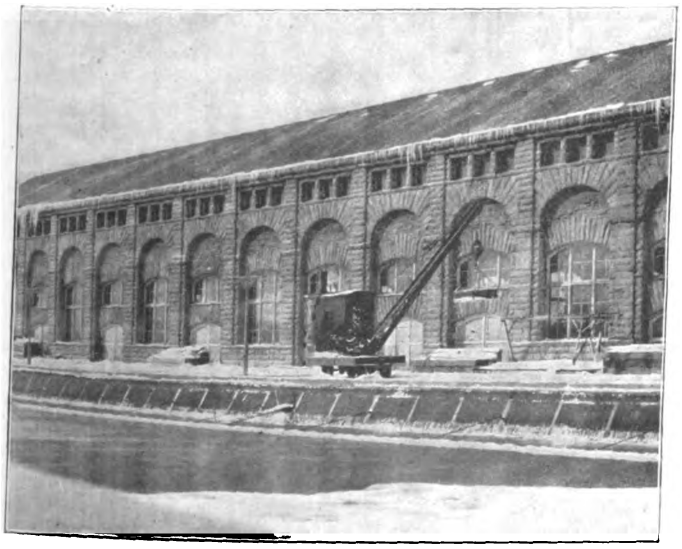

FIG. 2.—EXTERIOR OF POWER HOUSE, SHOWING STEAM CRANE.

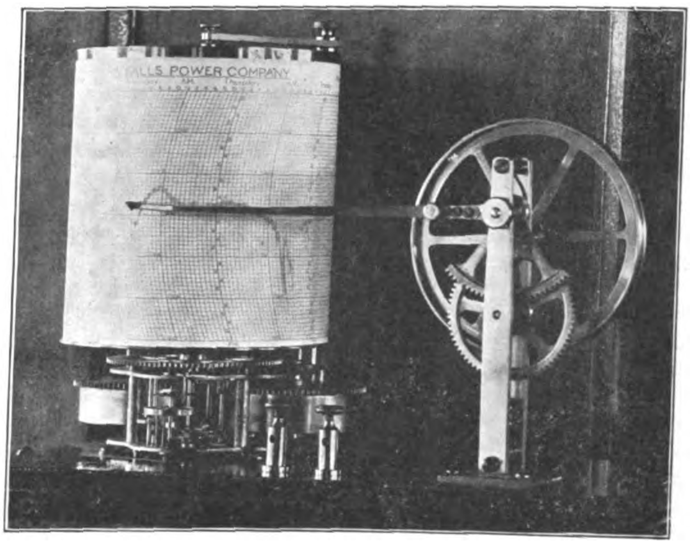

FIG. 3.—INSTRUMENT FOR REGISTERING HEAD OF WATER.

In former years the ice at the canal entrance froze so thick that the water supply was seriously diminished, and blasting was necessary to remove the ice. This could not happen now, because the mouth of the canal has been deepened from 12 to 16 ft., and a boom constructed near the old one at the canal's mouth; while a crib has been constructed off shore to turn the ice and other floating material down stream, instead of allowing it to follow the usual course and enter the canal.

During the winter months every effort is put forth to keep the Buffalo transmission line in operation, and thus far there has been no diminution of power on that line. Occasionally each dynamo is tested for load, shifting its load to the next, and so on for each machine. The fact that the water-wheel of any generator needs cleaning is indicated by a large valve opening and small load in kilowatts; then, of course, another generator is paralleled with those running, and that one is shut down and the wheel cleaned out.

◆

THE BELL COMPANY'S CENTRAL ENERGY SYSTEM.

BY W. S. HENRY.

The principles of the Hayes common battery or central energy system used by the Bell Telephone Companies may be understood by considering the accompanying diagrams showing the subscriber and switchboard circuits. The subscriber's circuit and its operation has been fully described in a previous number of the American Electrician, and hence it will be considered here only as it affects the operation of the switchboard circuit. In order to give the circuit in as simple and clear a manner as possible, no attempt has been made to represent the actual forms of the different pieces of apparatus or their relative positions. For instance, the relays are represented in the simplest manner possible and not ironclad, as some of them are made, nor with the contacts arranged as they are actually constructed. Special care has been taken, however, to simplify the arrangement of the connections, making it more graphical, so to speak, in order not only that the system may be readily understood, but that the relative polarity and position in the circuits of all the coils and contacts may be noted readily. These have all been correctly preserved, so that anyone having a blue print of the complete connections of the system can readily compare the two, and, with the aid of this description may, perhaps, understand the operation of the system better than before.

Fig. 1 shows the connections at one subscriber's telephone and the complete normal connections of this one-line circuit at the central exchange. Normally, the subscriber's receiver rests on the hook switch, and the contacts, 1 and 2, are open. Hence, the bell and condenser, which are in series, form the only circuit between the two line wires, *l* and *l*. Even this circuit will not allow a steady continuous current to flow through it on account of the condenser, which breaks the circuit metallically. Only a very small fraction of a very high frequency current, such as that flowing through the receiver during a conversation, can leak through it, on account of the great impedance or opposition offered to the flow of such a current by the bell magnets. The bell magnets are usually wound to a resistance of 1000 ohms and have a very high coefficient of self-induction for the high frequency voice currents. The only current that can flow through a subscriber's telephone when the receiver rests on the hook is the low frequency alternating or pulsating current used for ringing the bell. The impedance of the bell magnets is not high enough to prevent the ringing current, which has a frequency of only about 15 periods per second, from flowing through it, and the capacity of the condenser is sufficient to allow this current to flow through it. Therefore, the operator can ring up the subscriber in a way that will be presently explained.

Normally, the storage battery of 24 volts at the exchange is connected through a relay, across the two line wires, *l* and *l'*. This circuit may be traced as follows: *l-a-b*-line relay-*k*-battery-*h*-coil *H-m-i-l'*. $T\ C$ and $T\ C^1$ represent two coils of a message or toll counter, where such a counter is used. These have not proved very successful, and are in a more or less experimental state at present. No further reference will be made to them in this article. These two coils, $T\ C$ and $T\ C^1$, although not so shown here, are, of course, placed together in one counter.

When the subscriber removes his receiver from the hook, the central exchange is automatically notified of this fact, because the line lamp belonging to this circuit will light up and the operator in front of whom this particular lamp is located will proceed to ascertain the connection desired. The removal of the receiver from the hook connects the transmitter, *T*, and one winding, *p*, of the induction coil in series between the two line wires. The resistance of the transmitter and winding, *p*, is sufficiently low to allow enough current to flow from the battery through *h-TC-m-i-l'-p-l*-hook switch-transmitter, *T-e-l-a-b*-line relay-*k*, to operate the line relay. Hence, the circuit, *h-f-o-d-c*-line lamp-pilot relay-*x*, is closed at *c* and the line lamp lights and the pilot relay is energized. The pilot relay closes the circuit *h-f-o*-pilot lamp-*M-q-k* at *n*, causing the pilot lamp to also light.

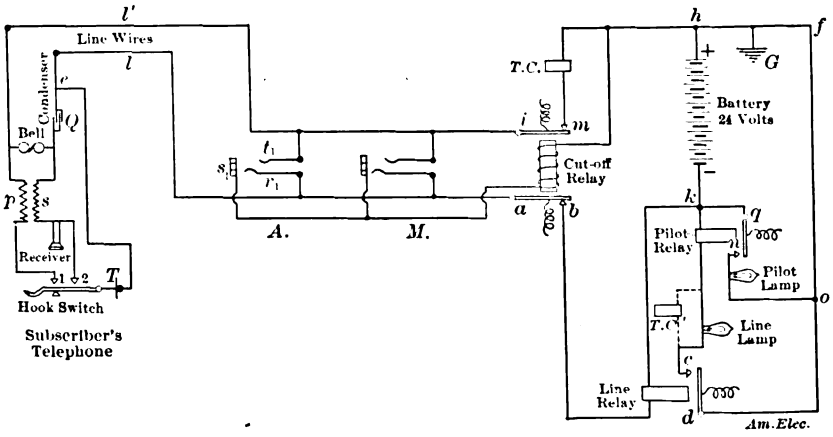

FIG. I.—DIAGRAM OF CONNECTIONS FOR ONE-LINE CIRCUIT.

There is one line relay and line lamp for each line circuit, but only one pilot relay and one pilot lamp for each operator's position. That is, all the circuits at one operator's position that pass through the line lamps are collected together and pass as one circuit through the pilot relay. The pilot lamp is usually placed near the top and in the center of the operator's position, where it can be readily seen from the chief operator's desk. The pilot lamps are usually larger and of higher candlepower than the line lamps. The object of the pilot lamp is to enable the chief operator to observe how the various operators attend to their work, for the pilot lamp will light up and go out every time a signal is received and answered, respectively, and hence, the chief operator knows that if it remains lighted an undue length of time, one or more calls are being neglected at that position.

Suppose that *A* represents the answering jack, and *M* any one of a number of similar multiple jacks on the same line circuit. The jack, *A*, and the line lamp, shown in this figure, would be at one and the same operator's position or panel. When a line lamp lights, as the result of a receiver being removed from its hook switch, the operator in front of the lighted lamp inserts the answering plug (usually the rear plug) of an idle cord circuit in the answering jack of the corresponding line. Then the circuit relations are shown in Fig. 2.

The insertion of the answering plug in the jack *A* produces several results. A current flows from the battery, *B*, along the path, w-t_1-9-p-l-T-e-10-r_1-supervisory relay, *SR*, and closes the shunt circuit at *u n*, around the supervisory lamp, *SL*. Current then flows from *B* along the path *h*-line cut-off relay CR-s_1-Rb-Rd-n-u-v-B, and causes the cut-off relay, *CR*, to open the circuit at *b* and *m* and thus cut off the line relay circuit from the line circuit. Furthermore, the battery, *B*, supplies current for the subscriber's transmitter, *T*.

Rb and *Rd* are merely resistances. When the supervisory relay, *SR*, is energized the resistance, *Rd*, shunts the supervisory lamp, *SL*, and thus prevents it from lighting. The resistance, *Rb*, is inserted to limit the strength of the current to a suitable value. The operator now closes her listening key, *LK*, thereby bridging her receiving circuit, 3-s_2-Q_2-R_2-4, across the tip and ring strands of the cord circuit at *g* and *j*, and then asks "What number?"

Before proceeding further with the operation of the switchboard, it will be well to consider some of the apparatus and connections. Although two batteries, *B* and B^1, are shown for the sake of clearness, they are really a single battery. The operator's transmitter, T^1, is in a local circuit, as shown; Q_2 is a condenser, and RC is a retardation coil. The retardation coil not only limits the strength of the current in any on transmitter circuit, but it also enables current to be supplied to all the operator's transmitters from one common battery without producing cross-talk and interference that would otherwise result. The condenser, Q^1, improves the transmitting qualities by allowing the rapid fluctuations to charge and discharge through it instead of through the retardation coil, which would seriously smooth them out and produce inarticulate sounds. The condenser, Q_2, in the operator's secondary circuit, prevents the flow of a large steady current from the battery, B, through the receiver, R_2.

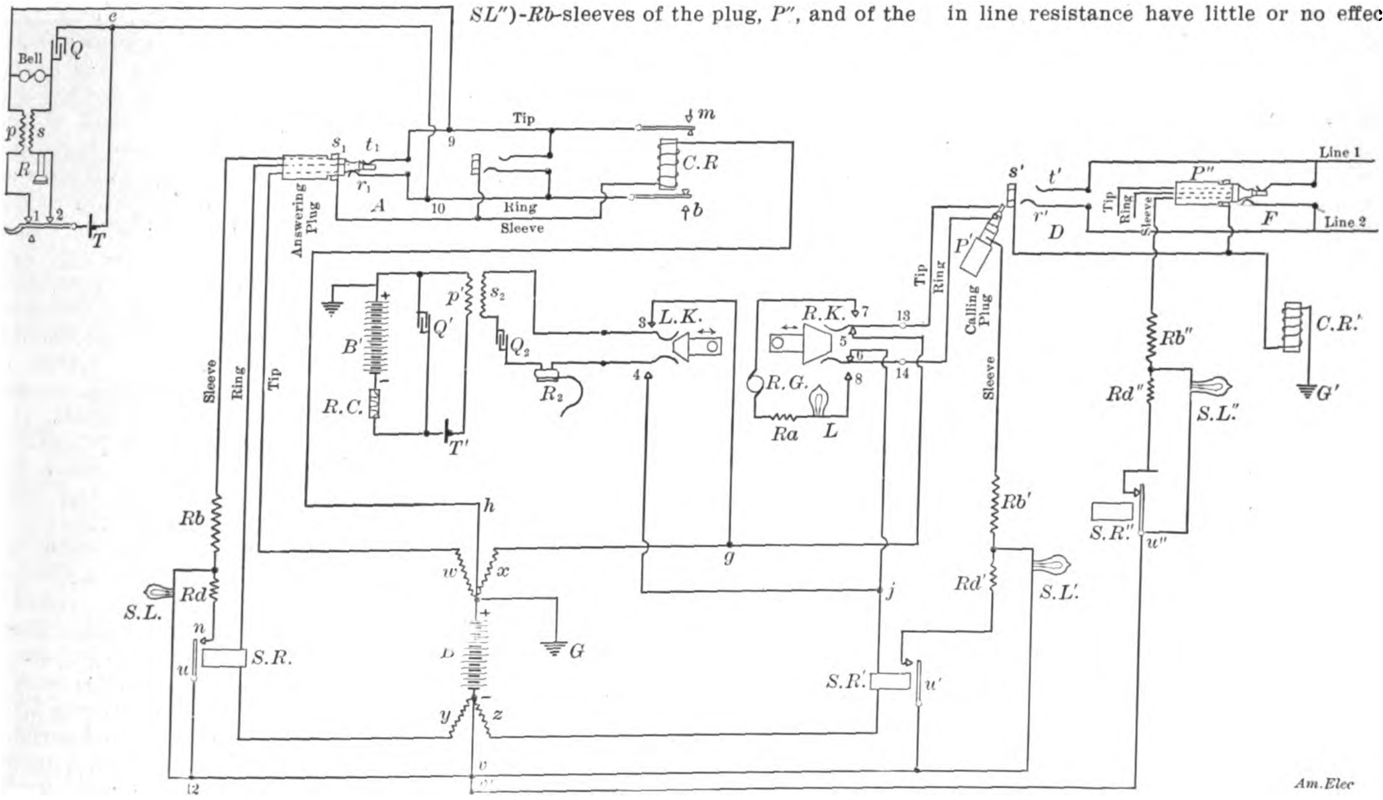

FIG. 2.—DIAGRAM OF CONNECTIONS, HAYES CENTRAL ENERGY SYSTEM.

The rapid fluctuations that produce articulate speech in the operator's and subscriber's receivers flow through the following circuits: s_2-Q_2-R_2-4-j-SR^1-z-B-x-g-3-s_2 and B-w-t_1-9-p-1-2-R-s-Q-e (or through p-1-T-e, thereby inducing a current in s-R-2-T-e-Q)-10-r_1-SR-y-B. The current originating in either of these two circuits (at s or s_2) flows through its half of the repeating coil, x z y w, and induces a current in the other half of the repeating coil which flows in the other circuit. The supervisory relays, SR and SR^1, are wound so as to have a low inductance, and hence offer comparatively little opposition to the voice currents..

Returning to the operation; after the operator has ascertained the number desired by the calling subscriber, she makes what is known in multiple switchboard parlance as the busy test, in order to determine whether the desired line is already in use at some other section of the switchboard. This she does by touching the tip of the calling plug, P^1 (usually.the front plug) to the sleeve of the called-for subscriber's jack, D. If the line is not busy, the sleeve of the jack, D, and the tip of the plug, P^1, are both simply grounded, the former through 13-5-g-x-G, and the latter through the cut-off relay, CR^1 to G^1; hence the tip of the plug and the sleeve of the jack are at the same potential and there is no tendency for any current to flow in the operator's receiver circuit (the listening key, LK, being closed before the test is made); no click being produced in the operator's receiver, R_2, the operator knows that the line is not in use and she will immediately insert the plug in the jack, as shown at F.

Ifthe line is busy, due to a plug previously inserted in one of the jacks belonging to this line, as at F, a current will be flowing through the circuit, B-v-v'-u''-Rd'' (or SL'')-Rb-sleeves of the plug, P'', and of the jack, F, cut-off relay CR'-G'-G-B. (In reablity, G' is connected by a wire with G; that is, the cut-off relay, CR', is grounded at G and not at a separate ground, G', as shown here for the saks of simplicity.) The current flowing through the circuit just traced raises the potential of the sleeve, s'', above the potential of the ground and a click is produced when the operator touches the tip of the plug, P', to the sleeve, s', of the jack of a busy line. This click is caused by a current that flows through the receiver, R_2, while charging the condenser, Q_2. The operator informs the original calling subscriber that the line is busy, and if no request is made for another connection, returns both plugs to the normal position upon the table.

When the operator finds the line not busy and inserts the calling plug in the jack, as at F, current flows through b-SL'-RB'-s'-CR'-G'-G-B, thereby raising the potential of all sleeves on the jacks of this line above that of the ground, which will show that this line is busy if a test is made upon it at any other section of the switchboard, as described above. After inserting the calling plug in the jack the operator releases her listening key and closes the ringing key, RK. A current will then flow from the ringing generator, RG, through 7-13-tip of plug P'-tip-spring t'-line 1-subscriber's bell and condenser line 2-ring spring r'-ring of plug P', 14-18-lamp L-resistance Ra. The lamp L is used as a sort of tell-tale signal. If it remains lighted an undue length of time there is probably a short-circuit at some ringing key or elsewhere on that circuit. The resistance, Ra, is adjusted to allow the proper strength of current for ringing the bell to flow through the line circuits. By using a resistance in this manner the variations in line resistance have little or no effect upon the strength of the ringing current. Moreover, in case of a cross or short-circuit on a line, no injuriously large current can be drawn from the ringing generator.

Having rung the called-for subscriber's bell, the operator restores the ringing and listening keys to their normal positions and proceeds to attend to other calls, merely noting whether the supervisory lamp, SL', goes out after a reasonable length of time. If it does not go out she rings again with the same ringing key. If then it does not presently go out, she informs the original calling subscriber that the called-for subscriber does not answer his telephone call.

When the subscriber called for removes his receiver from the hook the supervisory lamp, SK', goes out, because enough current cannot flow through the supervisory relay, SR', due to the subscriber's talking circuit of comparatively low resistance, being connected across the two line wires in place of the high-impedance bell magnets. The battery, *B*, now furnishes current over the tip and ring sides of both line circuits, for both subscribers' transmitters. The circuits are now in the proper position for conversation between the two subscribers.

As soon as either subscriber hangs up his receiver, the supervisory lamp on the corresponding side of the operator's cord circuit will light, and when both receivers are hung up both supervisory lamps will light; in the latter case the operator will immediately withdraw both plugs from the jacks, because the lighting of both lamps indicates to her that both subscribers have finished using their telephones. In case only one supervisory lamp remains lighted, the subscriber on that side of the cord circuit probably desires a second conond connection. The operator will then close her listening key to get the new number desired from the subscriber who has not hung up his receiver. She then removes the plug on the side of her cord circuit corresponding to the dark lamp and inserts it, if she finds the line not busy after making the busy test, in the jack of the subscriber's line desired.

The ringing current may be an alternating or pulsating current. In some exchanges the generator furnishes a pulsating current and one brush, say the negative, is permanently grounded; a double action or reversing key is used for ringing. This key is not shown in Fig. 2 on account of the complication it would have introduced in the diagram. When the key is pushed one way a positive pulsating current is sent out over the *ring* side of the line circuit. This current may return through the tip side of the line circuit or through the ground, depending upon whether the subscribers' bells are connected across the two line wires or between one line and the ground. When the key is pushed the other way, a positive pulsating current is sent out over the *tip* side of the line circuit and returns through the ring side or the ground, for the same reason as given above. Hence, two bells, one rung by a current in one direction and the other by a current in the opposite direction, may be connected across the two line wires and either bell desired may be rung. Or one ordinary telephone bell may be connected between each line and the ground, and either bell desired may be rung. In either case, the result is a two-party line with selective ringing and a metallic line circuit to talk over.

By combining these two methods it would be possible to have four subscribers on one pair of line wires, two of which would have their bells rung when the key is pushed one way and the other two when the key is pushed the other way. One ring and two rings could be used for calling in each position of the switch. This would give a four-party line circuit, with a metallic circuit for all four subscribers to talk over and a partially selective ringing system.

BOILER FEED PUMP OPERATION IN ISOLATED PLANTS.

BY J. R. CRAVATH.

There are in common use two general methods of operating boiler-feed pumps in small plants. One of these is to run the pump continuously at a very slow speed, the speed being adjusted to the rate that will keep the water at the proper height in the boilers all the time. The other is to work the pump intermittently, at a much higher rate of speed, and at such times as the boilers need water and the condition of fires permits. The capacity of the feed pumps in small plants is usually many times greater than needed to supply the boilers if run at full speed continuously, and the engineer has to choose between the two methods or a combination of them. Neither of them is free from objections, but they are the best the engineer in charge can do with the apparatus at hand, and their relative merits are worth considering.

If a pump be run continuously at a very slow speed no great amount of cold water is thrown into a boiler at once; consequently the internal boiler strains and the interference with the steam pressure are the least. The first point is probably of the most practical importance, especially if soft coal is used (as it is in most cases), because, as every fireman who handles bituminous coal knows, there are times in the round of firing operations when it is easy to get heat enough to compensate for the cooling effect of the feed water. On the other hand, if the pump is run at intervals at moderate speed, there is less waste of steam, due to leakage around the steam and water pistons of the pump. That this waste of steam must take place is shown by the fact that a pump must be in first-class condition to pump at all when it is run very slow. If the water passes through feed-water heaters on the way to the boilers and the pump is run continuously, the water entering the heater cold will be warmed to the highest attainable temperature before leaving. If the pump is run intermittently, the temperature of the feed water will be more dependent on the maximum capacity of the feed-water heater and the skill of the engineer. If not more than the quantity of water that will stand in the heater is pumped at one time, so that the water going to the boilers can stand and warm in the heater between pumping times, the feed water will enter the boiler at as high a temperature as in the former case, but some watchfulness is needed to insure this, and it is not always convenient to pump just when the water in the heater is warm.

These remarks apply only to small plants where there are only one or two feed pumps, and where, in order to have sufficient pumping capacity to cover all possible conditions, the feed pump is large in proportion to the work that is ordinarily required of it. It is customary to put in two feed pumps in duplicate, or a feed pump and an injector, or inspirator. In order to be able to work a feed-water pump somewhere near its maximum speed, so as to avoid waste of steam due to working too slow, it is not a bad idea when putting in a plant of this kind to make the pump that is to be used most of the time as small as may be without danger of having it fall short of the steaming capacity of the boilers. It can then be run continuously, at least during full load, without wasting the large amount of steam that a larger pump would.

The discussion of feed pumps and their rate of working naturally leads up to another question which is of considerable interest at the present time, namely, the use of electric motors for driving feed pumps. This is a question that comes up with more force in large plants than in small ones, but is to be considered everywhere that electrical energy is being economically generated. The use of electric motors for driving auxiliary apparatus around a steam plant is undoubtedly on the increase, although the best engineers are divided in opinion as to the economy of it, all things considered. Those who favor electric motors for this purpose point to the very high steam consumption per horse-power-hour by direct-acting steam pumps and small steam engines of all kinds, and the high efficiency of electric motors driven by energy supplied from the large, economical units of the generating plant. The higher efficiency of electric motors for the work when run at full speed is now generally admitted, though there was a time when it was questioned.

The points that the opponents of electric driving of pumps and other auxiliaries now make are that the investment for electric driving is so much greater than for steam, and that the efficiency of the electric motor in practice is much reduced by the necessity of running at less than full speed, to do which wasteful resistance must be introduced in the circuit. For every kilowatt of motor capacity installed to drive feed and condenser pumps a corresponding capacity must be added to the engine and generator capacity, and this, it is claimed, so adds to the total investment upon which interest and depreciation must be figured, that there is no advantage in operating auxiliaries by electric power. Be that as it may, it is evident that if feed pumps are to be operated by electric motors, too much consideration cannot be given to the necessity of either varying the speed of the pumps or having a sufficient number of pumping units, so that the number of pumps running can be adjusted to the amount of water to be pumped.

In some cases serious mistakes have been made by putting in shunt motors or induction motors on feed pumps where the capacity of the pump was such that it was desirable for the greater part of the time to run at less than full speed. The speed could only be reduced by the use of a rheostat in the case of the direct-current motor, so that much of the apparent advantage of the electric drive was thrown away. The solution of the difficulties with both steam and electric feed pumps that have been discussed here lies in the selection of the sizes of pumps adapted to the needs of the plant, so that as far as possible there will always be a feed pump which can be run at nearly full speed to supply the demands of the boilers. While this ideal condition cannot be realized fully in practice, it is often possible to come much nearer to it than has been done in the past.

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SECTIONAL OR WATER-TUBE BOILERS.

The many valuable features of safety, economy, ease and small cost of repair, rapid steaming qualities and freedom from damage and danger, even when forced beyond their normal rating, have brought the sectional and water-tube type of boiler into great favor among engineers, and have resulted in its development in many widely different and interesting forms.

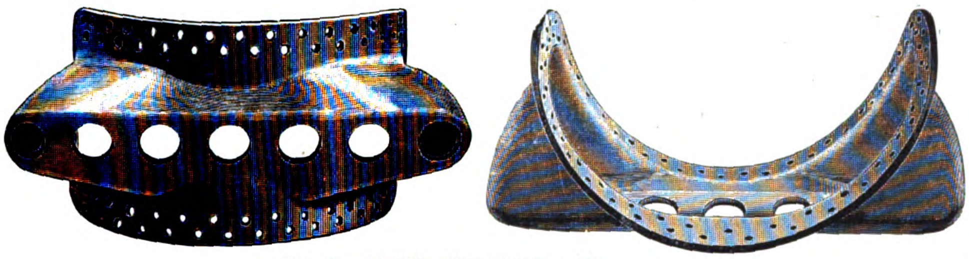


FIG. 2.—FORGED STEEL CROSS BOX.

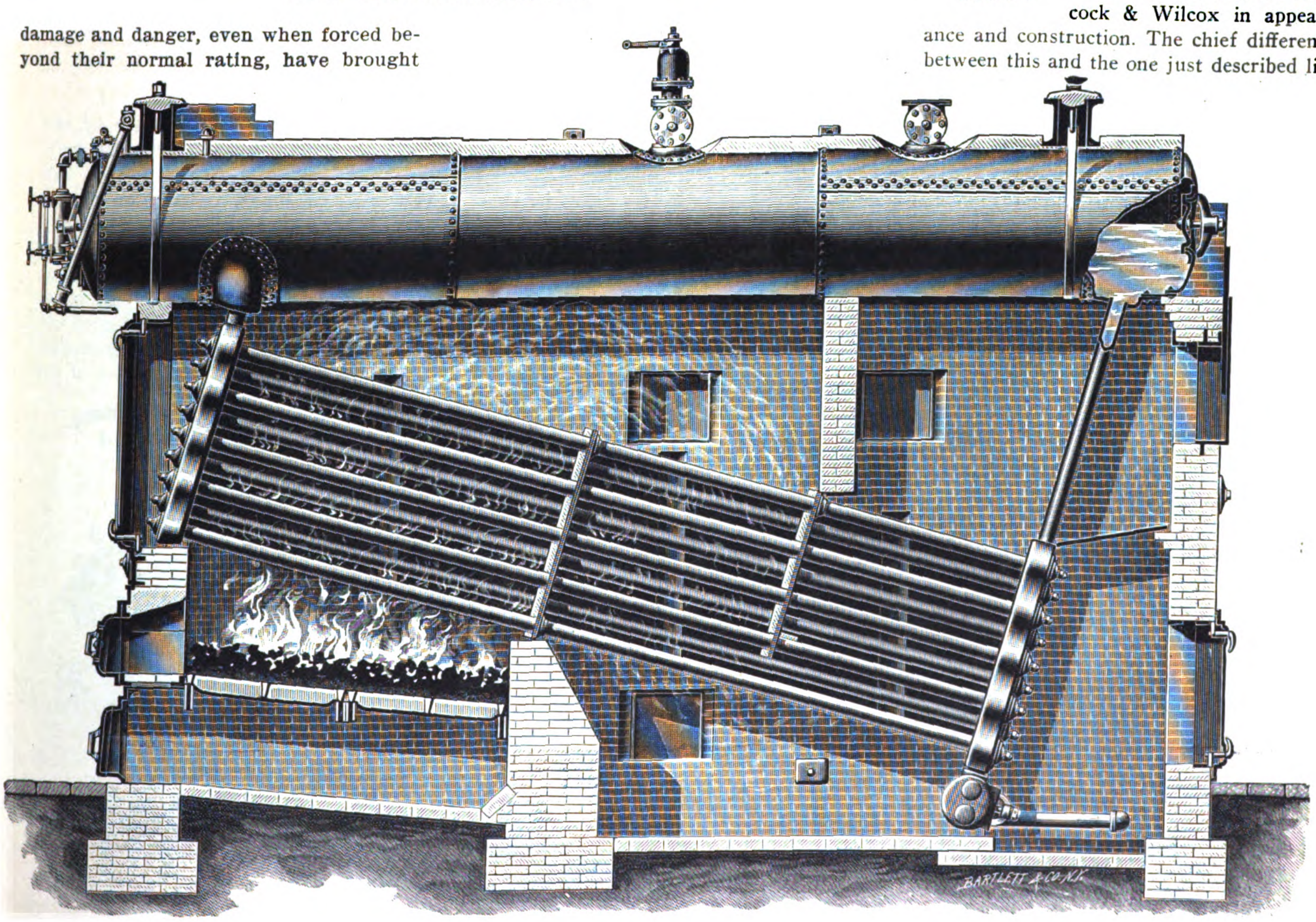

BARTLETT & CO. N.Y.

FIG. 1.—BABCOCK & WILCOX WATER-TUBE BOILER.

The Babcock & Wilcox Company, of New York, makes the well-known boiler shown by Fig. 1. The boiler consists of a number of lap-welded wrought-iron tubes expanded into zig-zag wrought-steel headers (see Fig. 2), which are connected to a forged-steel cross box (see Fig. 2), riveted to the steam drums by tubes; the front connection is shown by Fig. 5. The whole structure is flexible, so that any expansion or contraction of the different parts will not have injurious effects; the boiler itself being entirely loose from the setting it is not affected by the different rates of expansion of its different parts. Hand-holes are provided in the headers, one in front of each tube, so that the tubes may be thoroughly examined and cleaned with ease, and removed, and new ones put in in a few hours if necessary. As indicated in Fig. 3, the path of the gases is always substantially at right angles to the tubes, which are "staggered" so as to facilitate the mixture and consequent combustion of the gases. The feed water is discharged in the steam drum so as to meet the rush of hot water and steam at the front end; most of the scale-making salts are precipitated and carried down the rear tubes, to be deposited in the mud drum.

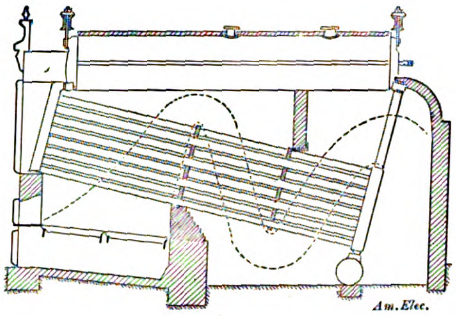


FIG. 3.—PATH OF GASES

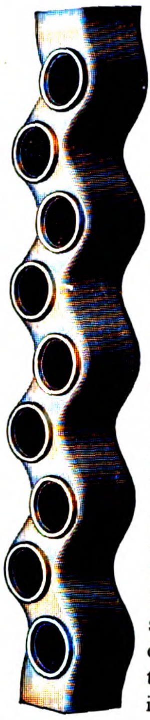


FIG. 4.—B. & W. HEADER.

Fig. 6 shows a boiler almost identical with the Babcock & Wilcox in appearance and construction. The chief difference between this and the one just described lies in the use of a special grade of cast steel for the cross boxes and headers in place of wrought steel. This special brand, known as Globe steel, has very much the

same properties as wrought steel, being capable of hammering out flat and bending double cold without showing signs of cracks. The header is illustrated by Fig. 7. This boiler is built by the Tudor Boiler Manufacturing Company, Cincinnati, Ohio.

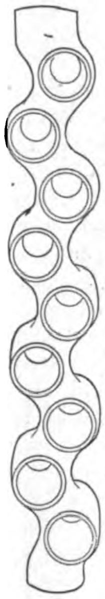


FIG. 7.

Another boiler of the same general class is the improved Root boiler, built by the Abendroth & Root Manufacturing Company, New York, and illustrated by Fig. 11. In this boiler the tubes are held in groups of two in separate headers, which are united by U-shaped connections held against the headers by bolts, and made steam-tight by a very simple metallic packing, shown in detail in Fig. 8. The circulation is good in these boilers, and they have been found to be efficient steam generators, which has given them favor in street railway, power and electric light installations.

The Aultman & Taylor Machinery Company, Mansfield, Ohio, build a water-tube boiler of essentially the same construction as the B. & W. and Tudor boilers. The headers are of the sinuous type, like those used in the Root boiler, and the material of which the cross boxes, headers and mud drums are built is open-hearth cast steel. This boiler is marketed exclusively by the Cahall Sales Department, Pittsburg, Pa.

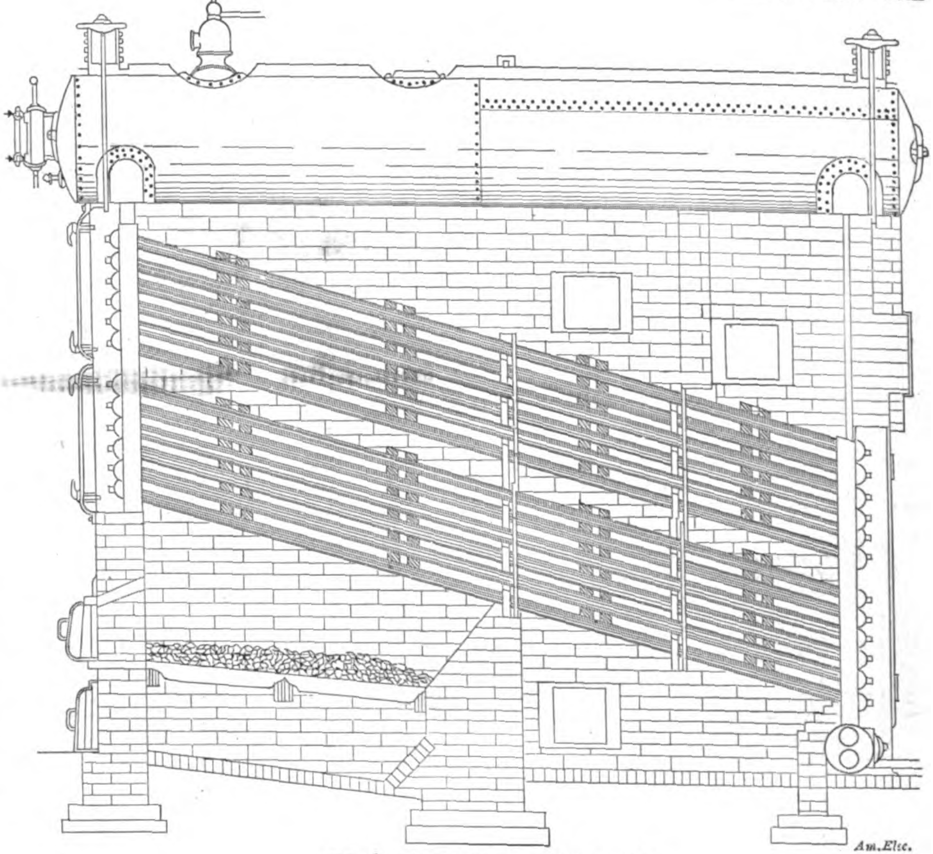


FIG. 6.—TUDOR WATER-TUBE BOILER.

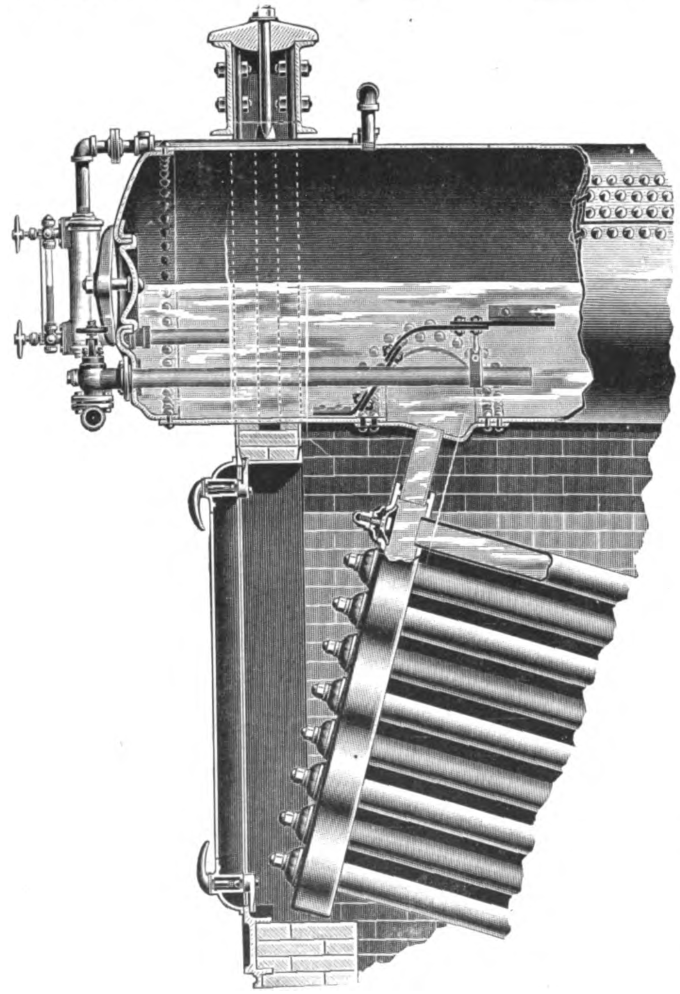


FIG. 5.—PARTIAL VERTICAL SECTION BABCOCK & WILCOX BOILER.

The Heine safety boiler, while of the water-tube and steam-drum class, differs from the B. & W. type in that all the tubes are expanded into two water legs made up of flat steel plate, thoroughly stayed and riveted to the steam drum, as seen in Fig. 10, and are arranged parallel with the drum. Openings are provided in the outer plates of the water legs so that each tube may be readily inspected, cleaned and re-expanded or renewed without disturbing any other part of the boiler, very little time being needed for an entire cleaning. The course of the gases under the boiler is indicated by Fig. 9. A new form of hand-hole cover, made of drop-forged steel plate, and shown in Fig. 12, is in course of development by the builders. A gasket is used to make the joint tight. Thus far the new cover has not been applied commercially to boiler, but will be put in use in the near future. The boiler just described is the product of the Heine Safety Boiler Company, St. Louis, Mo.

The Worthington boiler, made by the New York Safety Steam Power Company, New York, and illustrated by Fig. 15, will at once appear to be a combination of two boilers of the B. & W. type put together, except that in place of a number of "downcomers," four large ones are substituted, two being placed at each end. This boiler has all the desirable qualities of good circulation, accessibility and large disengagement area in common with others of the same type, and it has also the element of extreme compactness.

Fig. 14 represents the boiler of the Stirling Company, Chicago, Ill. Here three banks of slightly curved tubes connect three steam drums with the mud drum

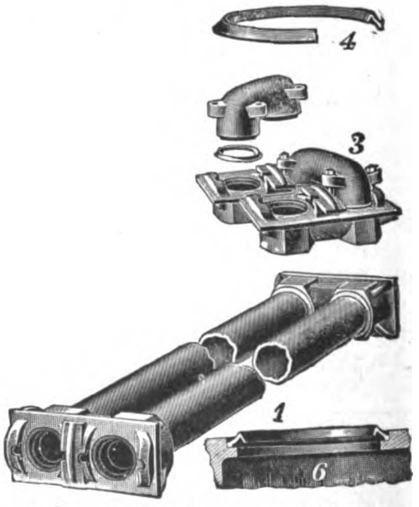


FIG. 8.—METALLIC PACKING, ROOT WATER-TUBE BOILER.

below. The circulation is good, and extensive disengagement surface is furnished, so that the surface is quiet, and priming is not likely to occur. The bend in the tubes permits them to adjust themselves to any unequal expansion without injury to any part of the boiler. Fire-brick partitions force the gases into contact with every part of the tubes, and communicate the heat of combustion to the water very thoroughly; besides, they tend to keep up a constant temperature inside the setting by absorbing heat where the fire is hottest, and giving it out when the fire is covered with fresh fuel; this stored heat also helps to produce complete combustion of the volatile gases given off by the coal just after firing, by keeping its temperature up to the ignition point. Of course these remarks concerning the beneficial effect of fire-brick walls apply to other boilers having them, as well as to the Stirling.

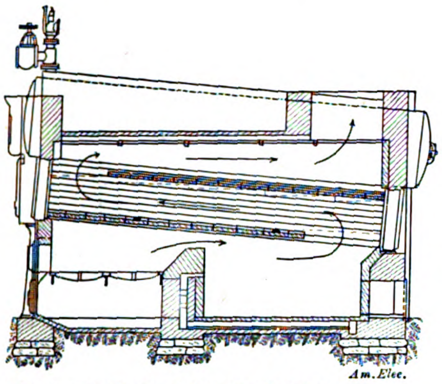


FIG. 9.—PATH OF GASES IN HEINE BOILER.

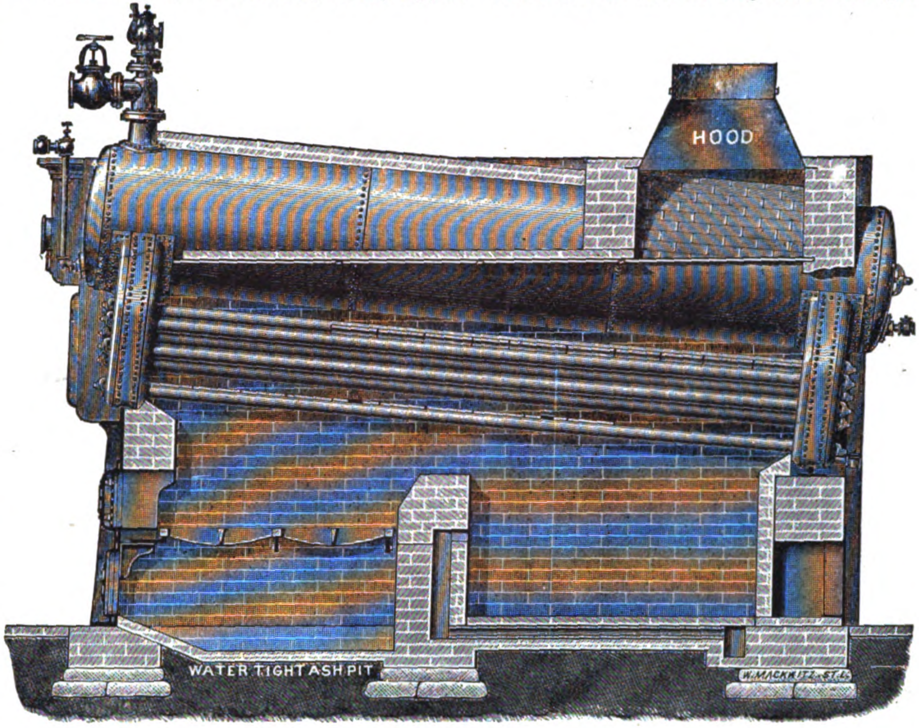


FIG. 10.—HEINE SAFETY BOILER.

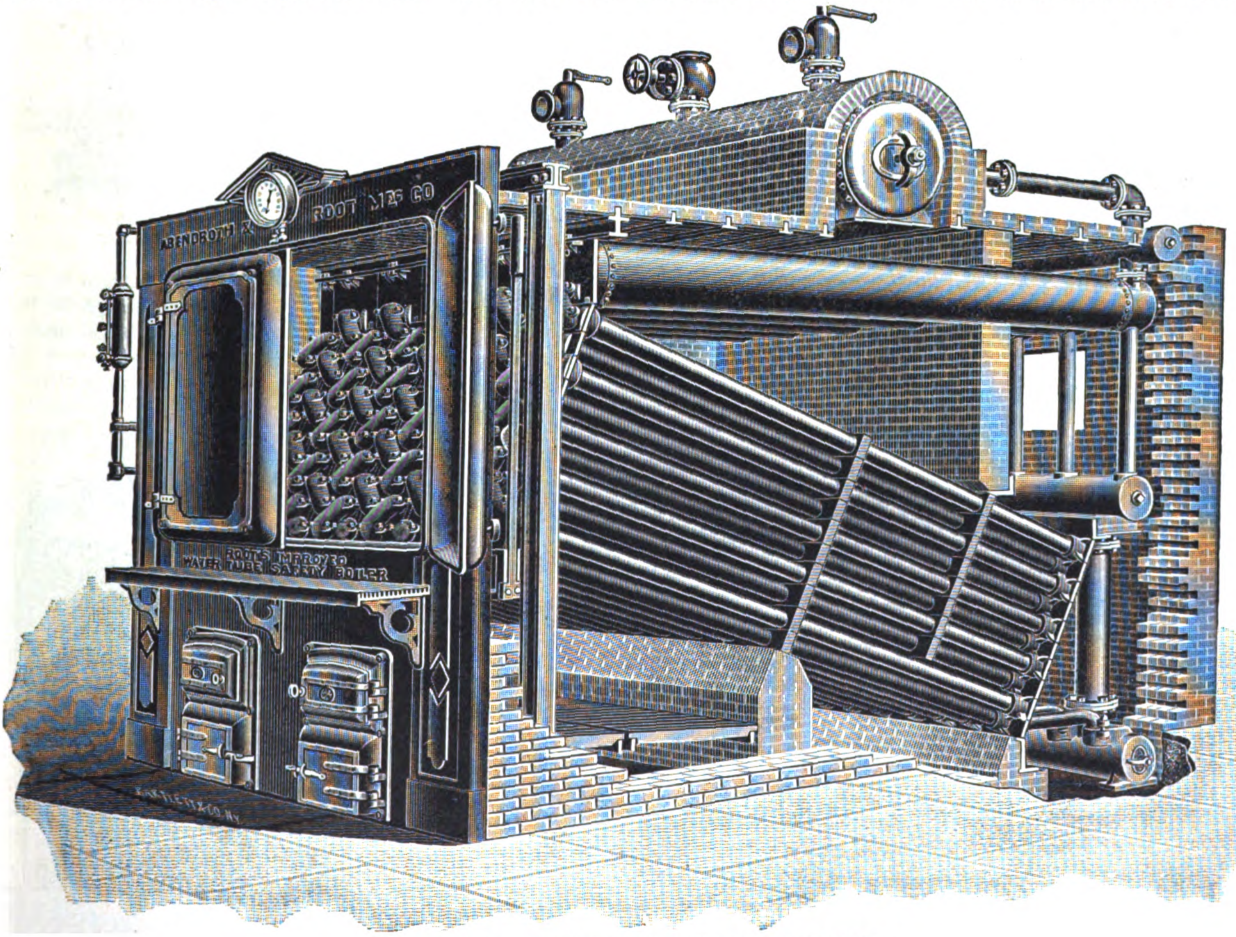

ABENDROTH & ROOT MFG CO
ROOT'S IMPROVED WATER TUBE SAFETY BOILER

FIG. 11.—IMPROVED ROOT WATER-TUBE BOILER.

The Cahall vertical boiler, built by the Aultman & Tayor Machinery Company, is illustrated by Fig. 13. The construction of this boiler is extremely simple. It consists of two drums connected by substantially vertical tubes, as the engraving plainly shows. The tubes are inclined outward at the top, leaving an inverted conical space in the center, in which are provided deflecting cones to baffle the gases and force them into contact with the tube surfaces. Offsets in the fire-brick of the setting force the gases back toward the center after they pass each of the deflecting hoods. The upper drum is annular in construction, the hole through the center serving as a flue through which the gases pass to the stack. In order to provide for continuous circulation "down-comers" are carried outside the setting from the upper drum to the lower one; one of these is shown on the

left of the engraving. Hand holes and manholes are provided in the cap sheet of the upper drum. The boiler is supported on four lugs bolted to the lower drum, and is left entirely free for expansion at all points. The engraving shows the boiler equipped with a chain-grate stoker, but, of course, it may be hand-fired like any other boiler.

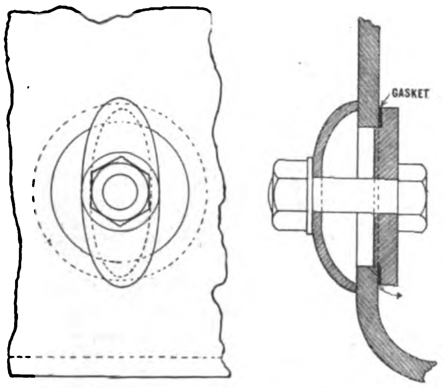


FIG. 12.—GASKET FOR HEINE BOILER.

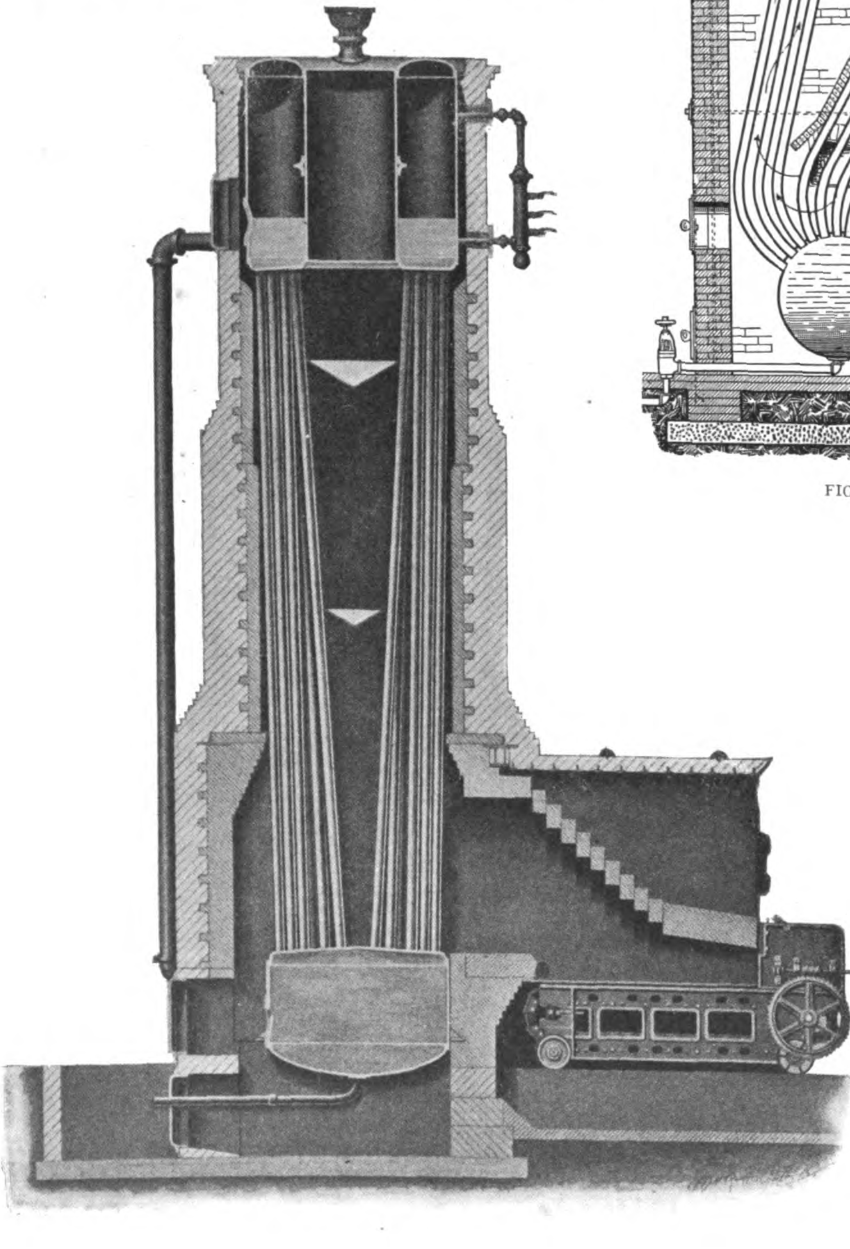


FIG. 13.—CAHALL VERTICAL BOILER.

The Tudor Boiler Manufacturing Company, previously mentioned, also makes a vertical type of water-tube boiler, known as the Lynn boiler, and shown in Fig. 16. Like the Cahall boiler, it consists mainly of two steel drums connected by straight tubes; the upper or steam drum is made a little deeper than the lower one, so as to give plenty of steam room. The tubes are arranged in circles; the outer rows are of a larger diameter than the inner ones, and have smaller tubes inside of them, which act as "downcomers" to carry the water down to the lower drum and provide circulation. The upper drum has five openings in the top, so that the tubes can easily be examined and cleaned, or a tube removed and replaced without inconvenience. The fire-brack setting presents the advantage of stored heat, just mentioned, and the straight path of the gases makes it easy to obtain a good draft with a chimney of moderate height.

Resembling the Lynn boiler in many particulars is the Wicks vertical boiler, a sectional view of which is presented in Fig. 17. The arrangement adopted in this boiler is the use of down draft. A vertical fire-brick partition is built between the tubes, which compels the gases to go up in front and then down between the tubes at the back. The front group of tubes act **as risers, while the rear group act as "downcomers." Plenty of steam room is provided, in most cases ranging from 3 to 6 ft. As in the Tudor boiler, the tubes**

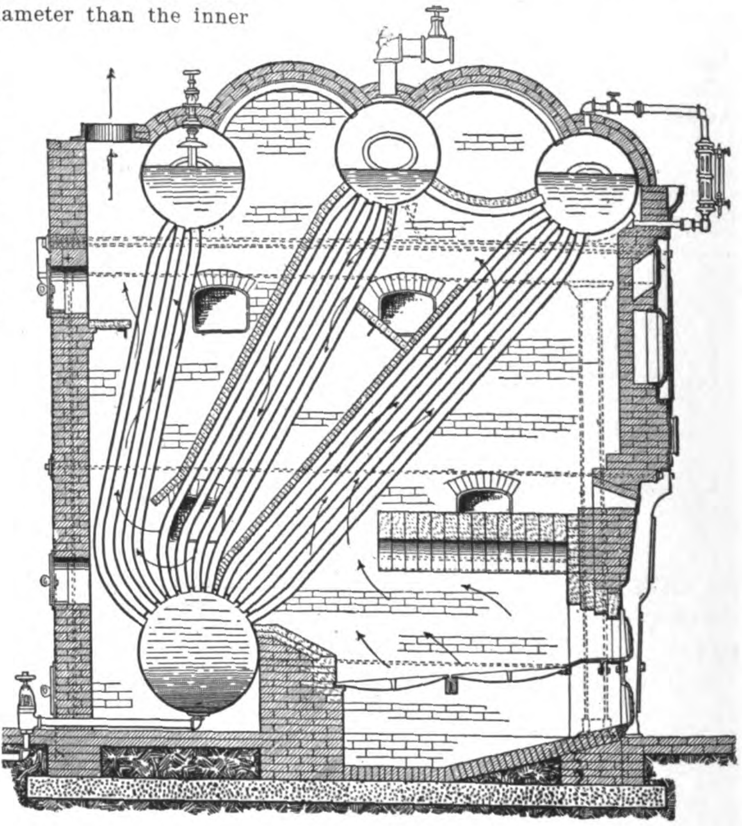


FIG. 14.—STIRLING WATER-TUBE BOILER.

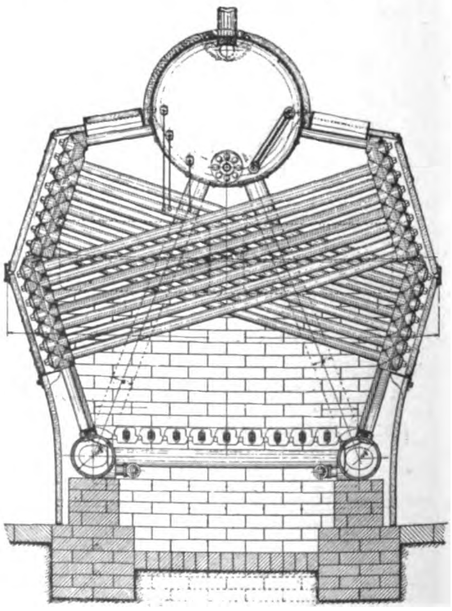


FIG. 15.—WORTHINGTON BOILER.

may be easily examined and cleaned through the manhole openings in the upper and lower drums. This boiler is made by Wicks Brothers, Saginaw, Mich.

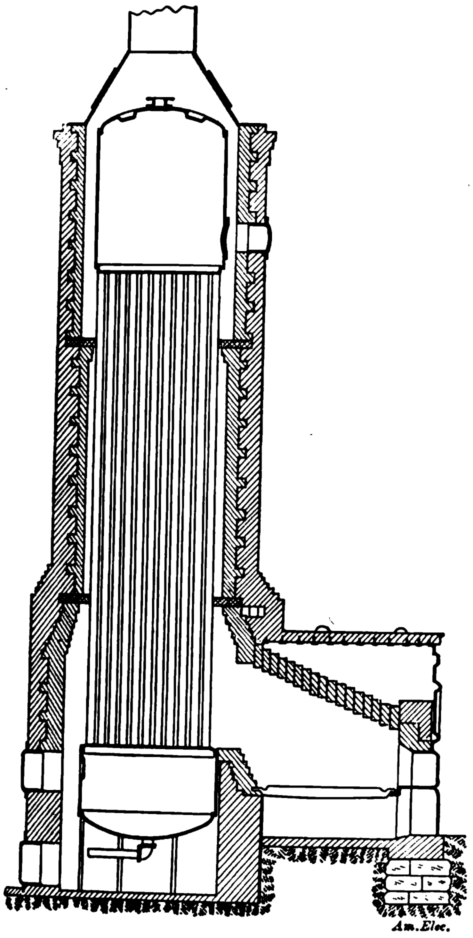


FIG. 16.—LYNN BOILER.

A very peculiar boiler of the vertical water-tube class is the Hazleton "Porcupine" boiler, shown in section in Fig. 19. This boiler consists of a central vertical cylinder, with short tubes closed at one end expanded into it in such positions as to baffle the ascending gases and facilitate their mixture. It is evident from the construction that there can be no steady or continuous circulation, but that it must necessarily be convulsive; however, the tubes are so short as compared with their diameter that an effective circulation takes place, which is evidenced by the evaporative efficiency of the boiler and the small amount of scale which forms in the tubes. It is even highly probable that the convulsive action tends to keep the tubes clean, by blowing out any small particles of scale which form, thus preventing any considerable incrustation. The details of construction of the upper portion of the boiler are illustrated in Fig. 18, which shows a diaphragm to which is attached a cylinder separating the upper and lower parts of the boiler. This cylinder, which is open to the lower part of the boiler, carries tubes open at both ends radiating from it and extending into the main tubes, so that steam drawn from the top of the boiler must pass to the ends of these tubes exposed to the heat of the fire, thereby drying and, most of the time, superheating. The Hazleton Boiler Company, Rutherford, N. J., is the maker.

The Morrin "Climax" boiler, manufactured by the Clonbrock Steam Boiler Company, Brooklyn, N. Y., like the Hazleton boiler, has a central vertical cylinder, but in place of the straight tubes it is provided with a large number of peculiarly curved tubes expanded at one end into the outer shell; the other end enters lower down and passes through the outer shell, and is expanded into a concentric inner shell, which does not quite extend to the water-level, and serves as a downcast for the tubes to supply them with water. As this inner cylinder need not be steam or water-tight it is simply bolted together, so as to be easily removed in case of cleaning or repair. The tubes above the water-line act as a superheater for the steam generated in those lower down.

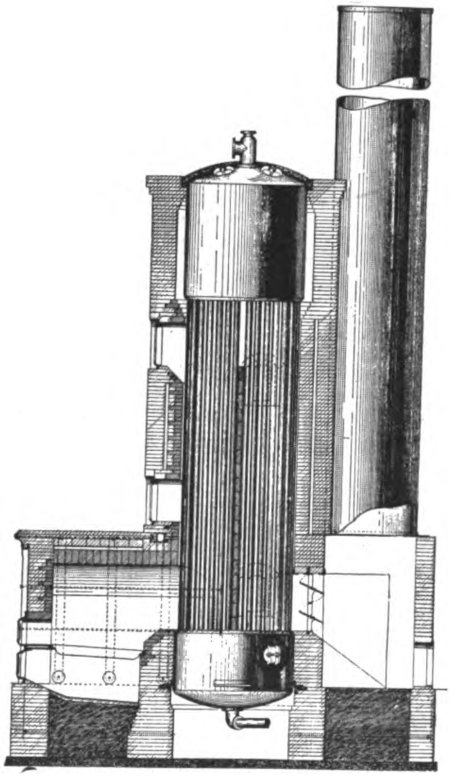


FIG. 17.—WICKS VERTICAL BOILER.

The Berry safety boiler, built by Robert Wetherill & Co., Chester, Pa., and illustrated by Fig. 20, although not of the sectional or water-tube type, is presented in this article because of features which place it in the general category of so-called "safety" boilers, as distinguished from the ordinary horizontal return-tubular construction. The boiler consists of two concentric vertical cylinders, between the walls of which are inserted numerous small tubes, as plainly shown by the engraving. The peculiar shape of the cap sheet which joins the upper edges of the two cylinders and the curved crown sheet at the bottom, together with the shortness of the tubes, renders the use of stays unnecessary. The circulation within the boiler is upward alongside the inner or flue sheet and downward alongside of the outer shell. The course of the gases is indicated by the arrows. A horizontal fire-brick partition about midway of the inner shell forces the gases from the furnace through the lower bank of tubes, and they return to the central flue through the middle bank of tubes and pass outward again through the extreme upper tubes to the stack, a baffling partition being placed between the outer shell and the casing, at a level midway between the middle and upper banks of tubes.

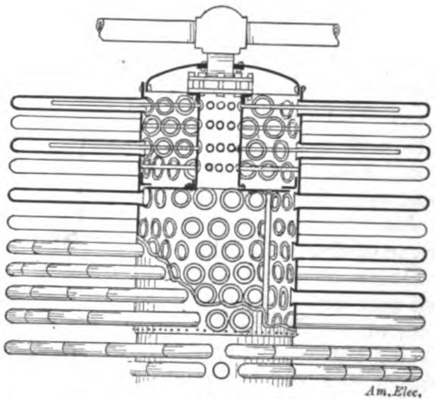


FIG. 18.—DETAIL OF PORCUPINE BOILER.

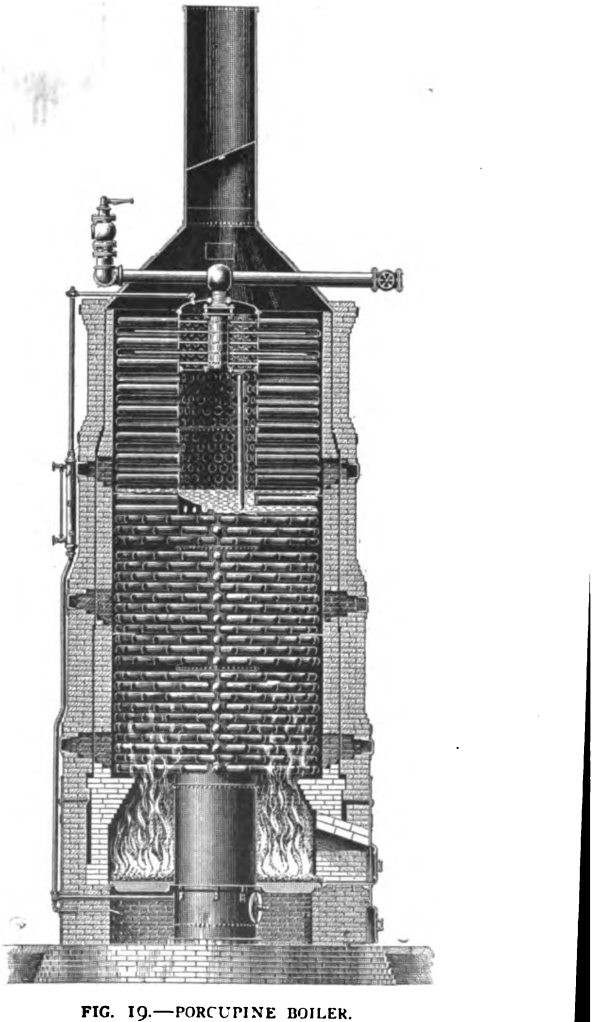


FIG. 19.—PORCUPINE BOILER.

In order to facilitate water circulation, a flat nest of pipes is arranged immediately over the fire, one terminal of this nest or coil being connected to a pipe running up to a point about 12 ins. below the water level in the boiler, and the other end opening into the boiler near the bottom. Feed-water is introduced into this coil and mingles with many times its own volume of water that is at the temperature of the steam, so that it reaches the boiler at a point above the temperature of precipitation, and is carried with whatever sediment may be in it past all the highly-heated surfaces to the water line, where it is delivered to the boiler and mingles with the slowly descending current near the outer shell.

The firebox is square and lined with a layer of fire-brick separate from the ring of brick which protects the extreme lowest part of the water space from the fire. One of the unique features of the boiler is its outer casing, the space between which and the boiler shell proper constitutes a flue for the gases, as previously described. This outer casing is mounted on rollers, so that it can be revolved to bring the doors opposite any point of the boiler shell. On the interior of the casing is secured a tube cleaner, consisting of a vertical pipe with small horizontal outlets opposite the tubes of the boiler. By connecting the inlet of this arrangement to the boiler nozzle by means of a flexible hose, and revolving the casing, the tubes may be all blown out in a comparatively short time. The joint between the casing and the stationary part of the boiler is made by a flange buried in sand.

A description of the Caldwell water tube boiler will be found on another page of this issue.

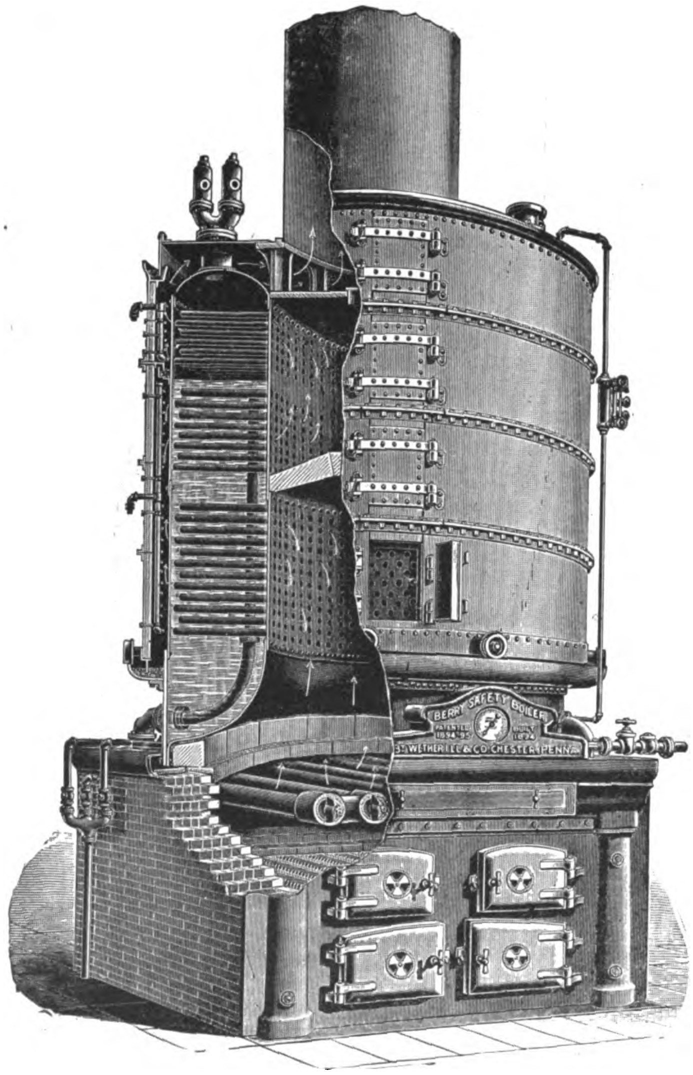


FIG. 20.—BERRY SAFETY BOILER.

Lessons in Practical Electricity

MAGNETIC PROPERTIES OF IRON.—THE ELECTRO-MAGNET.

As stated in the preceding Lesson, the reluctivity—specific reluctance—of all substances except a few minerals is practically unity (in metric measure). The excepted minerals are iron, nickel and cobalt. Iron has much the highest magnetic value, and as steel is made from iron ore, its magnetic qualities are approximately as high. There are other substances besides iron, nickel and cobalt that are slightly susceptible to magnetic influence, but the degree of susceptibility is so small as to be negligible. Even nickel and cobalt are so low in value as to be out of consideration independently of iron or steel; nickel-steel has found commercial application where high tensile strength is imperative.

In referring to the magnetic value of a material, it is usually more convenient to consider its ability to "conduct" magnetic lines of force than its opposition to magnetizing influence. Such ability is termed "permeability," and it is a complete analogue of electrical conductivity. There is no unit of permeability; it is a number, the value of which is the reciprocal of the reluctivity as expressed in metric measure. It is also the ratio between the magnetic flux induced by a given number of ampere-turns in any material other than air and the flux induced by a given number of ampere-turns in any material other than air and the flux induced in air by the same ampere-turns. In other words, it is the number by which magnetic induction in air is multiplied by the substitution of a better magnetic conductor for the air path.

The permeability of iron and steel is not the same in all pieces of metal. Moreover, the permeability of any one piece of iron varies with the degree of magnetization. Table I shows the permeability of average grades of wrought iron and cast iron at different degrees of magnetization (magnetic density), and illustrates very clearly both the effect of increase in density and that of varying the quality of the iron. The magnetic quality of iron is improved by any process that renders it either softer or more homogeneous, such as annealing and mixing in a small quantity of aluminum or silicon. The presence of either carbon or manganese in the iron is highly detrimental magnetically.

TABLE OF PERMEABILITY FOR IRON AT VARIOUS DENSITIES.

Density. per sq. inch.	Wrought Iron. Annealed.	Wrought Iron. Commercial.	Gray Cast Iron.
30,000	3,000	2,100	800
35,000	2,950	2,150	640
40,000	2,900	2,130	510
45,000	2,800	2,100	410
50,000	2,650	2,050	320
55,000	2,500	1,980	250
60,000	2,300	1,850	170
65,000	2,100	1,700	110
70,000	1,800	1,550	90
75,000	1,500	1,400	70
80,000	1,200	1,250	55
85,000	1,000	1,100	40
90,000	800	900	30
95,000	580	680	20
100,000	360	500	..
105,000	260	360	..
110,000	180	260	..
115,000	120	190	..
120,000	80	150	..
125,000	50	..	..
130,000	30	..	..
135,000	20	..	..
140,000	15	..	..

As the permeability of iron under ordinary conditions is from several hundred times to several thousand times that of air, it is evident that the flux created by the solenoid of Fig. 1 may be greatly increased by adding an iron core, as shown in Fig. 2. Such an arrangement is called an electromagnet. The effect of introducing the core may be demonstrated by comparing the reluctance of the air path through the coil alone with the reluctance of the iron core at any density commonly used in practice—say, 85,000 lines per square inch of path cross-section. The reluctance of any magnetic path is found by the formula:

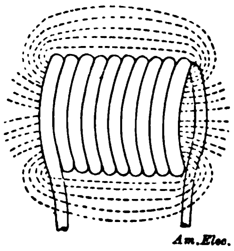


FIG. 1.

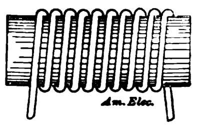


FIG. 2.

$$\frac{L}{2.54\,A\,\mu} = R \qquad (1)$$

in which L represents the length of the path in inches; A, its area at right angles to the direction of the flux, and μ, the permeability of the material. Assume the length of the coil to be 3 ins., and the area of its bore to be 5 sq. ins. The permeability of air is 1 (the reciprocal of its reluctivity in metric measure), so that for the coreless coil the reluctance would be

$$\frac{3}{2.54 \times 5} = 0.23622 \text{ oersted}$$

Now, assuming the core to be annealed wrought iron, to have a cross-section of 4.8 square inches, and to be 4 inches long, its permeability at a density of 85,000 will be 1000, and its reluctance

$$\frac{4}{2.54 \times 4.8 \times 1000} = 0.000328 \text{ oersted}$$

It was explained in a perivous Lesson that the flux produced by a given magnetomotive force is found by the expression *M. M. F. ÷ Reluctance = Flux.* Conversely, *Reluctance × Flux = M. M. F.* To produce a given flux, therefore, the magnetomotive force (ampere-turns × 1.257) required is directly proportional to the reluctance of the path. In the present case we are considering only one part of the complete path—that part within the coil—but the law holds good just the same. In the assumed case, the reluctance within the coil, without the core, is 0.23622 oersted; the reluctance of the core is 0.000328 oersted. Therefore, the ampere-turns required to furnish magnetomotive force for the interior path without a core would be 0.23622 ÷ 0.000328 = 720 times as great as those required by the core, for the same flux density (85,000 lines per square inch). If the cross-section and length had been identical in the two cases, the ratio would have been 1000.

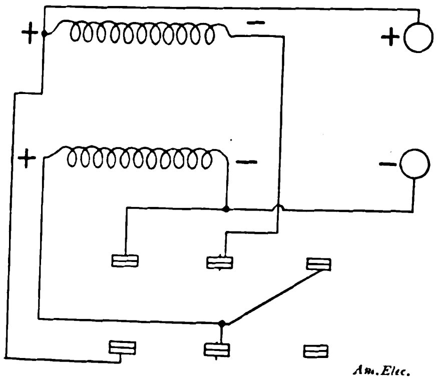


FIG. 1.—MR. CLARK'S SOLUTION.

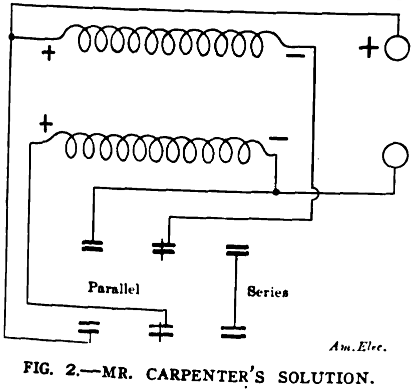


FIG. 2.—MR. CARPENTER'S SOLUTION.

In considering the coil with the core, it is necessary to take into account the length of the core instead of the length of the coil, for the reason that the flux in the core has greater importance as well as vastly greater numerical value than the flux in the air between the core and the wires of the coil, and the length of the core obviously affects the value of the flux within it. The value of the flux within the coil that does not go through the core is of no importance whatever on account of its relative smallness. It must not be supposed, however, that the only lines of force within the coil of an electromagnet are those in the core.

Letters on Practical Subjects

Mr. Woodbury's Problem in Field Connections.

To the Editor, American Electrician:—

Please find enclosed a diagram (Fig. 1) solving Mr. Woodbury's field connection problem, which appeared in the December number. The diagram is practically self-explanatory. The positive terminal of one field coil is connected permanently to the positive source of supply, and the negative terminal of the other field coil to the negative terminal of the source of supply. When the switch is thrown to the left, the two coils are put in parallel, the lower jaw connecting the positive terminals and the upper jaw connecting the negative terminals of the coils. With the switch thrown to the right, the coils are in series, the negative terminal of the upper coil being connected through the upper switch jaw and the cross connection to the positive terminal of the lower coil.

HAZEN CLARK.

Middlesex, Vt.

[This solution corresponds with the one furnished by Mr. Woodbury. A practically identical solution was supplied by H. H. Horton, Sheffield, Pa.—EDITOR.]

To the Editor, American Electrician:—

Enclosed please find a solution of Mr. Woodbury's "Problem in Field Connections" (Fig. 2). The diagram is so simple that it needs no comment. Throwing the switch handle to the left puts the field coils in parallel, and throwing the handle to the right connects them in series. This method of field connection would be very good for a motor which has to start under heavy loads often, as the torque could be made quite strong at starting by throwing the coils in parallel. This would obviate taking an abnormal draft of current from the mains. When the speed reached a high enough point the switch would of course be thrown over to the series position.

LESLIE E. CARPENTER.

New York.

[This solution, it will be noted, is almost identical with Mr. Woodbury's original. The switch makes precisely the same connections, the only difference in the arrangement being that in Fig. 1 the upper right-hand jaw is cross-connected to the lower left-hand jaw, while in Fig. 2 the two right-hand jaws are connected together. As far as mechanical convenience is concerned, the arrangement in Fig. 2 is preferable, as it necessitates making only one connection at each jaw. This solution was also sent in by H. S. Downerd, Schenectady, N. Y.; C. C. Hoke, Wilkinsburg, Pa.; A. W. Lee, Concord, Mass.; Wm. A. Loveland, Wilmington, Del.; L. R. McDonald, Montreal, Can.; J. L. Minick, Windber, Pa.; Louis C. Rugen, Jr., Bound Brook, N. J.; Sheridan C. Sell, Pittsburg, Pa.; Arthur B. Smith, Missouri Valley, Iowa; Stanley E. Smith, Cleveland, Ohio; W. E. Tower, Mattoon, Ill.; F. A. Ward, New Britain, Conn.; Edw. F. Weis, Chicago, and C. R. Wylie, Saginaw, Mich. —EDITOR.]

To the Editor, American Electrician:—

The accompanying diagram is a solution of the problem in field connections which was published in the December number. Throwing the switch to the left connects the positive terminals of the field coils together through the upper blade, and the negative terminals are connected together through the lower blade and the diagonal cross-connection, putting the two coils in parallel. The positive terminal of one coil and the negative terminal of the other coil are connected permanently to the supply circuit. With the switch thrown to the right the coils are put in series through the upper blade alone, the lower blade being idle in that position.

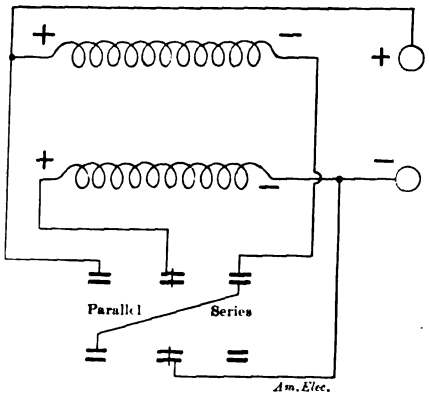


FIG. 3.—MR. BRUCE'S SOLUTION.

JOHN W. BRUCE.

Aitch, Ohio.

[This solution, which is obviously just as efficient as the original solution supplied by the author of the problem, was also sent in by C. N. Blennerhassett, Cincinnati, Ohio; Wm. S. Bury, Chicago; A. B. Case, Pittsburg, Pa.; S. Diamant, New York; James B. Dillon, Louisville, Ky.; H. S. Downerd, Schenectady, N. Y.; Fred. G. Dustin, Minneapolis, Minn.; E. L. Kennedy, Buffalo, N. Y.; C. A. Kuehn, Canton, Ohio; Fred. R. Price, Columbus, Ohio; C. W. Reid, River Fall, Wis.; Geo. G. Saunders, Rutherford, N. J., and D. W. Shirley, Rockford, Ill.

A Peculiar Circuit Trouble.

To the Editor, American Electrician:—

Recently a new alternator of the General Electric compensated field three-phase type was installed in a Montana town. Prior to the installation the system was run at 52 and 110 volts, about equally divided. After installing the new alternator the 52-volt lines were combined with the 110-volt circuit; but by accident one of the 52-volt transformers

was left in the circuit, and the new system failed to light up. After cutting out the 52-volt transformer there was no further trouble. Perhaps some of the readers of the American Electrician can explain the difficulty. R. G. Cooper.
Missoula, Mont.

Mr. Sutter's "Problem in Lamp Control".

To the Editor, American Electrician:—

I enclose herewith a diagram (Fig. 1) fulfilling the conditions of Mr. Sutter's "Problem in Lamp Control," which was published in your December number. As there may be several lamps supplied from each outlet, each wire from each outlet is carried to an individual fuse on the tablet board. The other side was led to the common terminal of a three-way snap switch, the alternative terminals of each switch being led to separate fuses on the tablet board. When the three-way switch is thrown to the right the outlet that it controls is connected to the main circuit in the ordinary manner; when it is thrown to the left, the outlet is connected between one side of the main circuit and an auxiliary terminal on the tablet board, which is connected to the main circuit through the emergency switch. The individual outlets, therefore, may be turned on and off in the ordinary way when the emergency switch is open, and closing the emergency switch connects up all of the outlets irrespective of the three-way individual switches. In either event both sides of each outlet are fused in conformity with the Underwriters' rules.

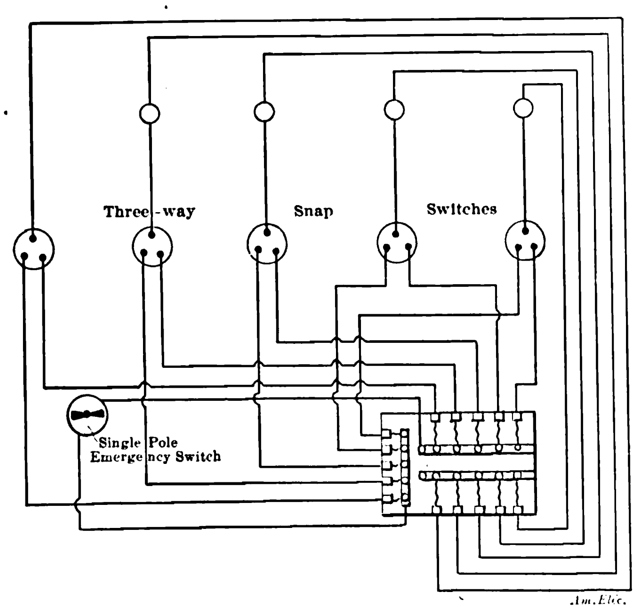


FIG. I.—MR. ESLER'S SOLUTION.

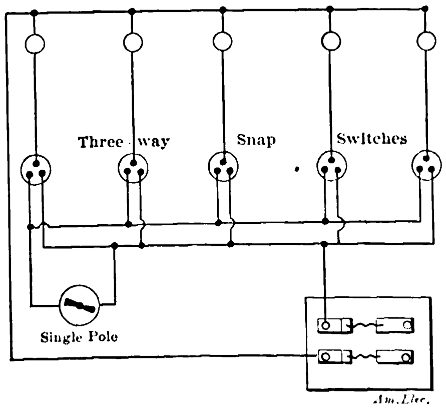


FIG. 2.—MR. ARSINO'S SOLUTION.

A. F. Esler.

Buffalo, N. Y.

[This plan agrees perfectly with Mr. Sutter's original solution. A practically identical solution was sent in by C. J. Drees, Little Rock, Ark.; O. H. Hutchings, Dayton, Ohio; H. W. Korhammer, St. Louis, Mo.; C. A. Kuehn, Canton, Ohio; Lewis C. Reynolds, Wards Island, N. Y., and Wm. A. Yandell, St. Louis, Mo.

Mr. Korhammer also submitted an interesting solution of the problem as applied to a three wire system, in which one-half of the outlets were wired to one side of the system and the other half to the other side, a double-pole emergency switch being used. —Editor.]

To the Editor, American Electrician:—

Enclosed please find a diagram (Fig. 2) submitted as a solution of Mr. Sutter's problem in the December number. One side of every outlet is connected to a common main which goes to the main fuse-block. The other side of each outlet goes to the common point of a three-way switch, which connects the outlet either to the off side of the single-pole emergency switch or to a main connected to the second terminal of the main fuse block. With the emergency switch open, each three-way switch will light the lamps of its outlet in one position and extinguish them in the other. With the emergency switch closed and all the three-way switches open, all of the lamps will be lighted, and throwing any of the three-way switches to the other side will merely shift the connection of that outlet without extinguishing the light.

C. Barnard Arsino.

Boston, Mass.

[This method of wiring fulfills the conditions of Mr. Sutter's problem in respect to the functions performed by the switches, but it is not, strictly speaking, a legitimate solution, for the reason that the original problem specified a tablet board, indicating plainly that the outlets must be fused individually, whereas Mr. Arsino's sketch shows merely a main fuse-block. Another objection applicable to this solution is that if there were more than two lamps per outlet, the wiring would not be permissible under the Underwriters' rules. This solution was also sent in by P. R. Brice, Baltimore, Md.; Geo. J. Brouillette, Worcester, Mass.; Geo. A. Burnham, Winchendon, Mass.; Wm. S. Bury, Chicago; Leslie E. Carpenter, New York; Hazen Clark, Middlesex, Vt.; H. L. Clark, Canton, Pa.; John L. Davis, Chicago; James B. Dillon, Louisville, Ky.; H. S. Downerd, Schenectady, N. Y.; Fred. G. Dustin, Minneapolis, Minn.; Edwin R. Fisk, Pittsfield, Mass.; H. L. Francis, Brooklyn, N. Y.; John H. Hamilton, Philadelphia, Pa.; C. C. Hoke, Wilkinsburg, Pa.; R. D. Howard, Lincoln, Neb.; Otto Kaestner, Milwaukee, Wis.; A. W. Lee, Concord, Mass.; Burton E. Lucas, Delray, Mich.; L. R. McDonald, Montreal, Can.; J. L. Minick, Windbur, Pa.; Rene Moncel, Montreal, Can.; Martin O'Connor, Milwaukee, Wis.; Geo. M. Ockford, Jr., Ridgewood, N. J.; C. R. Phillips, Philadelphia, Pa.; Fred. R. Price, Columbus, Ohio; C. W. Reid, River Fall, Wis.; H. E. Ryder, Marlboro, Mass.; A. Schuhman, San Francisco, Cal.; F. A. Ward, New Britain, Conn., and M. W. Younkin, Grand Junction, Iowa.—Editor.]

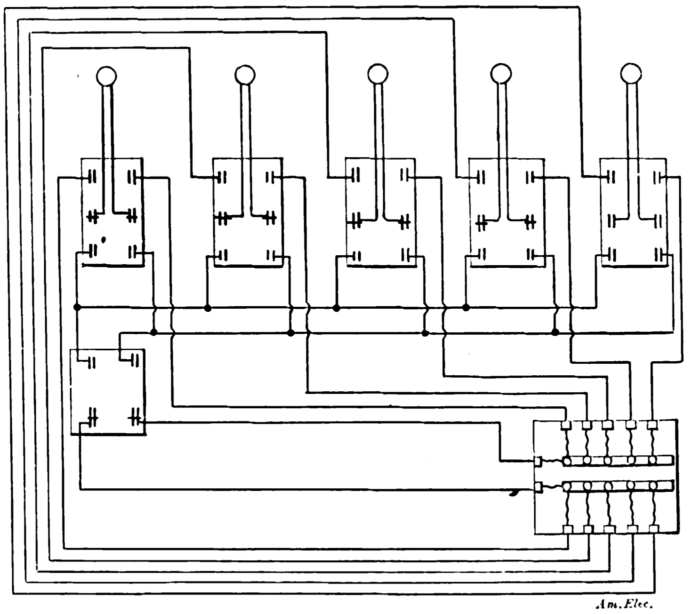


FIG. 3.—MR. WEIS' SOLUTION.

To the Editor, American Electrician:—

The accompanying diagram (Fig. 3) shows a method of wiring submitted as a solution to Mr. Sutter's "Problem in Lamp Control," which was published in the December number. The individual switches are double-throw knife-blade switches, and the emergency switch is a single-throw double-pole switch. When any one of the individual switches is thrown upward its outlet is connected to the panel-board in the ordinary way; when it is thrown downward the outlet is connected to the free terminals of the emergency switch. The other two terminals of this switch are connected to the bus-strips of the tablet-board through fuses, which of course are proportioned for the total number of lamps supplied from the outlets. The double-throw individual switches must not be left in an intermediate position, but always closed in one direction or the other.

EDWARD F. WEIS.

Chicago, Ill.

To the Editor, American Electrician:—

I enclose a solution of Mr. Chas. J. Sutter's "Problem in Lamp Control" (Fig. 4).

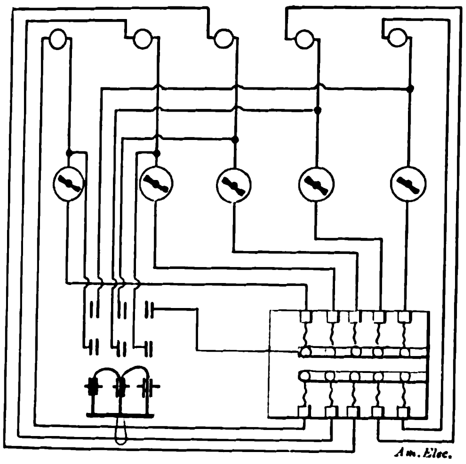


FIG. 7.—MR. SMITH'S SOLUTION.

For individual lamp control single-pole switches are used, all of which are placed in the same side of the circuit, so that the lower bus-strip of the tablet-board is always connected through its fuses to the outlets, the switches controlling the leads that terminate at the upper bus-strip. Supplementary wires are led from a point just beyond each individual switch to the emergency switch, which is of the triple-pole single-throw type with the blades all connected together. Five of the clips are connected to the outlet leads beyond the single-pole switches, and the sixth clip to the upper bus-strip of the tablet-board, so that closing the emergency switch connects all five of the switch leads from the outlets directly to the upper bus-strip of the tablet board, rendering the single-pole switches ineffective and lighting all of the lamps. A three-pole double-break snap switch may evidently be used in place of the knife switch shown in the diagram.

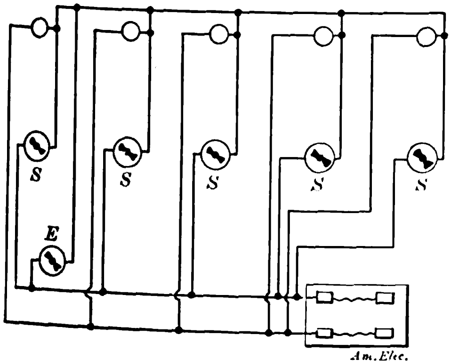


FIG. 8.—INOPERATIVE PLAN.

ARTHUR B. SMITH.

Missouri Valley, Iowa.

[This solution was also sent in by Jack S. Gibbs, Beaumont, Tex.; Geo. E. Gramm, Schenectady, N. Y., and Wm. A. Loveland, Wilmington, Del. While it does not correspond with Mr. Sutter's solution, it is an eminently practical plan for the number of outlets specified. Both this and the solution of Mr. Weis, however, fall short of the Underwriters' requirements; Mr. Weis' method protects the entire group of outlets through a single pair of fuses when the emergency switch is closed, so that if there are more than 12 lamps connected up, this arrangement would be prohibitive. Mr. Smith's method connects one side of each outlet directly to the mains without the intervention of a fuse, which is also contrary to the Underwriters' rules. It is extremely probable, however, that special permission could be obtained for the use of either arrangement, as the infringement of rules only takes place at rare intervals when the emergency switch is used.

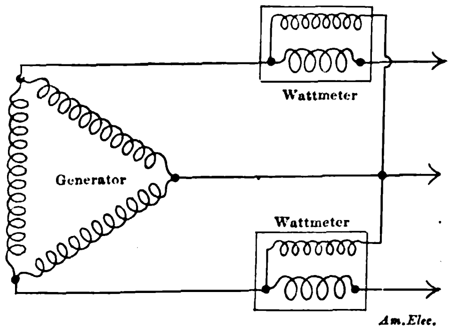
A large number of readers sent in the arrangement of wiring shown in Fig. 8, which is inoperative and is published merely in order to point out its defect. Tracing the connections, it will be evident that closing any one of the individual switches will connect all five of the outlets to the current supply, as the emergency switch taps put all of the outlets in parallel between the outlets and the individual switches. The emergency switch, therefore, has only the same function as each of the individual switches, and none of them affords individual control of the outlets.—EDITOR.]

◆

The Effect of Low Power Factor Upon Recording Wattmeters.

To the Editor, American Electrician:—

In the second column of "Queries and Answers" of the December number of your paper, in answer to the second question of "H. E.," the statement is made that "the power factor has no influence upon the direction of rotation" of an alternating-current wattmeter. As "H. E." refers specifically to the influence of a power factor of less than 50 per cent, it occurs to me that he may have in mind the performance of single-phase wattmeters connected to polyphase circuits, in which case it would seem the power factor may influence the direction of rotation. I refer to the particular conditions where two single-phase wattmeters are connected to a three-phase circuit, as indicated by the accompanying diagram. When the power factor is greater than 50 per cent, the arithmetical sum of the readings equals the power in the circuit, but when the power factor is lower than 50 per cent, the arithmetical difference of the readings gives the power, as is well known.



WATTMETER CONNECTIONS.

Chicago, Ill. ERNEST F. SMITH.

◆

Mr. Thompson's Mistake.

To the Editor, American Electrician:—

With reference to the accident described by Mr. O. C. Thompson in the December number of your paper, I would suggest the following as a probable explanation of the peculiar phenomena noted. A 104-volt alternating current attains a maximum e.m.f. of nearly 150 volts, or about 40 volts more than the normal e.m.f. of Mr. Thompson's direct-current circuit. When the alternating-current system was connected up to the direct-current circuits, at one instant the alternating current strengthened the field of the Jenney dynamo and reversed the current in its armature; at the next instant the field polarity was reversed and the armature current enhanced. In the former case no harm could result, as the time of action was too short; in the second instant, however, the generator supplying the alternating-current circuit was practically in series with the Jenney direct-current machine, causing an enormous momentary current to pass, and consequently blowing the fuse. The field polarity was reversed by the combined action of the superior alternating-current e.m.f. at the second instant mentioned, together with the armature reaction resulting from the enormous current flowing there, and this was aided by the self-inductive current when the circuit was broken by the fuse. As the fuse blew at the instant when the second set of conditions existed, the field was left reversed.

The probability is that the blowing of the fuse did not cut the voltmeter out, and the high e.m.f. generated in the machine by self-induction due to the sudden cessation of the heavy armature current caused the burn-out of the voltmeter resistance coils. The operating coil of the voltmeter has a mch lower resistance per unit of radiating surface than the resistance coils, hence it was not affected, which would account for its remaining uninjured while the resistance coils burned out (I infer that this was the case, as Mr. Thompson did not say that the operating coil of the instrument was destroyed). The lamps were cut out by the fuse when the voltmeter resistance coils burned out.

PHILIP M. GALLO.

Allegheny, Pa.

◆

Working a 100-Volt Recording Wattmeter on a 50-Volt Circuit.

To the Editor, American Electrician:—

Permit me to call attention to an error in the answer to "H. C. R." in the December issue. In regard to changing a 100-volt Thomson recording wattmeter to work on a 50-volt circuit, he is advised, and very correctly, to make no change in the instrument, but use it as it is "by dividing the constant by 2." Changing the constant when changing the voltage, as recommended above, although in accordance with an impression apparently held by many, is incorrect. If the potential on the armature circuit be reduced from 100 to 50 volts, the speed of the meter for a constant value of current in the field coils will be reduced one-half. This means that the registration would be but one-half, as are obviously the watts; consequently, the constant remains unchanged. When operating under the reduced voltage the "starting current" or minimum value of load to cause rotation will be doubled, but since lamps or other translating devices to be metered also take double the current, this objection is without weight. The same sensibility would be retained by providing a new resistance for the envelope, of such a value that the total potential circuit resistance (armature, shunt field and envelope resistance) would be one-half its former value. In this case the constant would correctly be divided by 2. GUY R. RADLEY.

Milwaukee, Wis.

Electrical Catechism

659. Explain the action of the storage cell.

The chemistry of the lead storage cell is somewhat complicated and physicists are not entirely agreed about what actually takes place. The most commonly accepted theory is as follows: When the cell is thoroughly charged, the positive plate is covered with lead peroxide (PbO_2), while the negative plate is covered with spongy metallic lead. (In speaking of storage batteries the positive plate is the one where the charging current enters and the discharge current leaves the cell.) During the discharge, the lead at the negative plate unites with the sulphuric acid (H_2SO_4), forming lead sulphate ($PbSo_4$), and setting hydrogen free. At the positive plate, the lead peroxide (PbO_2) unites with the hydrogen set free from the negative plate and forms a lower oxide (PbO) and water; this lower oxide then unites with sulphuric acid and forms lead sulphate ($PbSO_4$) and water. As the cell becomes discharged the acid thus unites with the plates and water is formed, so that the density or specific gravity of the electrolyte falls from about 1.22, when fully charged, to about 1.18 when discharged to the lowest safe limit. When the cell is charged by the passage of current in the opposite direction, the above processes are reversed. When the voltage is allowed to fall below 1.8 volts per cell, the lead sulphate is liable to change into an insoluble form, which reduces the capacity of the cell, and the cell is then said to be "sulphated." Care should therefore be taken not to allow the battery to become discharged too far. When the cell is being charged, the necessary voltage rises from 2.2 volts to about 2.5 volts per cell. When the cell is fully charged, the further application of current breaks up the water of the solution, liberating hydrogen gas at the negative and oxygen gas at the positive. These gases reduce the amount of the solution in the cell, both by the decomposition of the water and by the acid which is carried off in spray by the gases. This spray is also carried off if the charging current is too strong, so that the active material on the electrodes is affected at the surface much faster than nearer the center of the plate. On the other hand, if the charging current is less than about one-fifth of the normal current, the insoluble sulphate is apt to form and so injure the plates. The normal rate of charging is about 8 amps. per square foot of total surface of the positive plates. If the cell is charged or discharged too fast, the action is liable to be unequal on different parts of the plates, and so to cause the plates to bend or "buckle," since the active material expands during discharge.

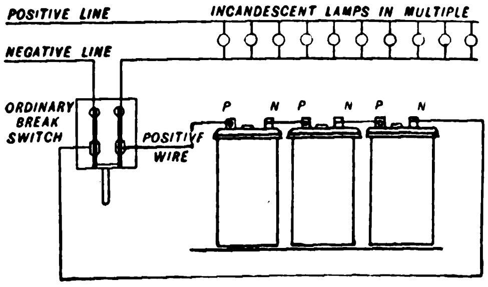


FIG. 1.—CHARGING BATTERY FROM INCANDESCENT LIGHTING CIRCUIT.

660. How is a storage battery charged? charged from dynamos giving nearly con-

Storage batteries are almost always stant e.m.f. When only a few cells are to be charged, they may be connected across a direct-current incandescent lighting circuit, in series with enough lamps to give the desired current. When a battery of fifty or more cells is to be charged, connection is made directly with the dynamo. In beginning the charge the dynamo should be adjusted to give from 2 per cent. to 5 per cent. nigher e.m.f. than that of the batteries. Both terminals of the dynamo should then be connected to the corresponding terminals of the battery, positive to positive and negative to negative. In ordinary central station practice, where the same dynamos must supply current to the lines at constant voltage and at the same time charge a battery, it is necessary to provide means for obtaining two different voltages. When the current required on the lines is small compared with that required by the batteries, the voltage of the dynamo may be adjusted to that required by the batteries, and an adjustable resistance may be inserted in the main line to reduce the line voltage to that required by the circuit. This is commonly done on railway trains, where the dynamo sometimes charges the batteries and at the same time furnishes current for lighting the lamps. On the other hand, when the battery is a smaller part of the entire load, provision is often made for an auxiliary dynamo to raise the voltage of the current used for charging the battery. Such a dynamo is called a "booster," and may be driven by the same power that operates the main dynamos, although it is more often driven by an electric motor.

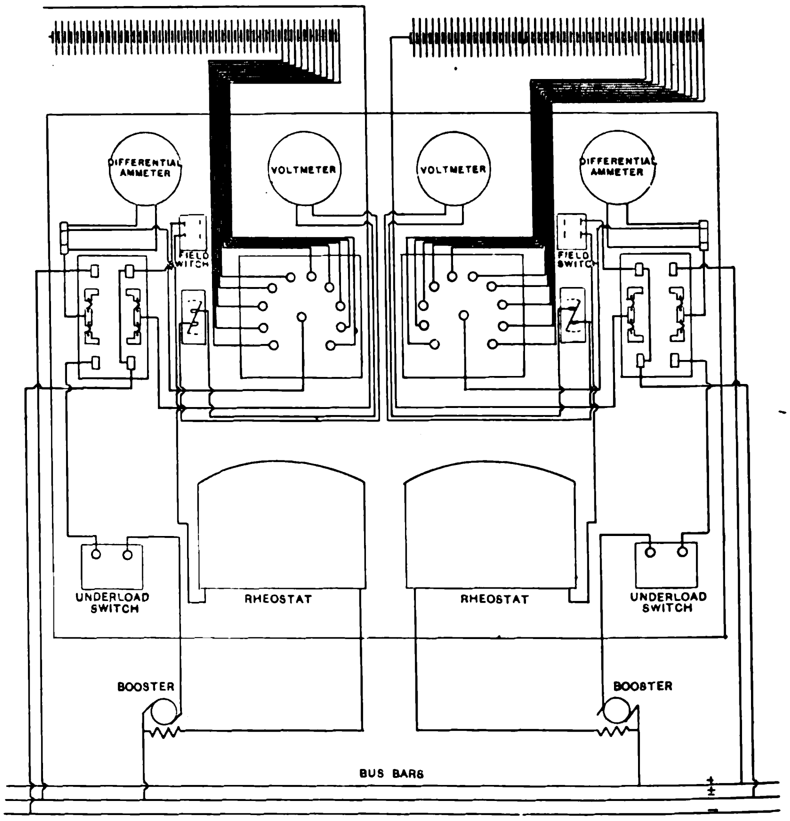


FIG. 2.—DIAGRAM OF SWITCHBOARD FOR STORAGE BATTERY ON THREE-WIRE SYSTEM.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Will the ⅙-hp motor described in "Electrical Designs" run satisfactorily with a four-pole cast-iron field magnet? J. T. K.

No. If you wish to use a circular frame make it of cast steel and use two poles. Four poles on such a small machine involves objectionable complications.

What protection should be used for the primary leads of a 1100-volt alternator laid in sand under a tile floor for a distance of about 25 ft.? H. A. H.

Use extra-heavy rubber insulation on the wires and put them in a single insulated iron conduit; or else use lead-covered cable with a suitable number of conductors.

If it were possible to make an alloy of double the conductivity of copper would a dynamo wound with wire of this alloy give double the output? S. W.

No. The copper losses in a dynamo of ordinary size are never more than 10% of its total output, so that with your hypothetical alloy the maximum increase in output would be about 5%.

How is the total capacity of a two-phase or three-phase generator figured when the capacity per phase is known? H. K.

If the e. m. f. and current per phase be represented by E and I respectively, the total output of a two-phase generator is

$$P = 1.414 \times E \times I.$$

That of a three-phase machine is

$$P = 1.732 \times E \times I.$$

What is meant by a 7x6x8 single-acting pump? (2) What is a rotary converter? G. L.

A pump having a steam cylinder 7 ins. in diameter and a water cylinder 6 ins. in diameter, the stroke of both being 8 ins. If the pump is really single-acting, this term means that water is drawn in on one stroke and forced out on the other. (2). Refer to the article on the rotary converter, in the December number of this paper.

In rewinding a 110-volt machine for 220 volts what changes are necessary besides reducing the size of the wire on the armature one-half? G. R. R.

The number of coils on the armature should be doubled, the turns per coil remaining the same. The field coils should be rewound with twice the present number of turns, using wire of one-half the present size.

Can a 110-volt, 10-hp. motor be used on a 220-volt circuit in series with dead resistance? I. L. R.

Not satisfactorily. When operated in this way any variation in the load causes a corresponding variation in the speed, and if the load be removed suddenly when the machine has been carrying considerable load with the resistance adjusted for that load, the speed will immediately increase to an abnormal rate and probably destroy the armature.

How can I increase the torque of a motor? E. G.

By strengthening the field. In order to do this the field-magnet coils will have to be rewound with a larger size of wire. If the increase in torque is only desired at starting, this can be accomplished by putting series coils on the field-magnet connected up so as to assist the shunt coils. If anything like regular speed is desired these should be cut out after the motor gets up to speed.

What proportion of the total power does a single wattmeter indicate in a three-phase line, and in a six-phase line? (2) How many wattmeters are necessary to indicate the total power of a balanced polyphase system. (3) How many are necessary for an unbalanced polyphase system? W.

One-third of the total in a three-phase circuit, and one-sixth in a six-phase circuit. (2). Two wattmeters for a three-phase line and five wattmeters for a six-phase line. With a balanced system, however, it is not necessary to measure the total power; the reading of a single meter multiplied by the number of phases is sufficient. (3). One meter less than the number of phases.

What is the relation between the efficiency of a machine and its power factor? (2) What would be the difference in the power output of a three-phase generator if the lights were all on two of the phases? B. A. F.

There is no direct relation between the efficiency and the power factor. A low power factor, however, reduces the efficiency of the machine by increasing the copper losses for a given output or input in true watts. (2). A three-phase generator loaded on only two phases should be loaded to only two-thirds of its rated full load. The machine will carry a trifle more than this because of the absence of current in the third phase, resulting in a larger radiating surface per unit of energy lost in the armature windings.

What is the value of a condenser used in connection with a steam engine? (2) How is the size of steam piping between a boiler and an engine calculated? E. D. B.

The condenser reduces steam to water, and as this occupies much less space than the steam, a vacuum is produced which assists the steam pressure on the opposite side of the engine piston and increases the output of the engine as well as its efficiency. (2). The size should be such that the steam velocity does not exceed 6000 ft. per minute. An approximate formula frequently used is the following:

$$D = 0.41 \times \sqrt{\text{horse-power}},$$

in which D is the internal diameter of the pipe. This is, of course, a rough formula, being based on a certain steam consumption per horse-power per minute.

How is the insulation resistance of wire measured? (2) Is the neutral of a three-wire system always grounded? (3) What is the correct resistance of a copper wire one mil in diameter and one foot long? (4) What is the formula for figuring the drop in a direct current circuit? G. I. B.

A bight or a coil of a few turns of the wire is immersed in a tank of salt water and the resistance is measured between the bare end of the wire outside the tank and a plate arranged horizontally within the tank. (2). Not always, but it is much better practice to ground it than not. (3). At the temperature of melting ice the resistance is 9.59 ohms; at 75° Fahr. it is 10.51 ohms. It is customary in figuring wiring to consider the resistance per mil foot 10½ ohms. (4).

$$\frac{2100 \times I \times D}{E \times \text{circ. mils}} = \text{Per cent drop.}$$

In this formula I is the current, D is the distance (one-half the total length of the wire), and E is the voltage at the load.

What is the effect of putting resistance in series with the shunt field of a compound-wound motor? (2). If the shunt field of such a motor is opened when it is running at full speed and load, will it continue to run at the same speed and load? J. J. R.

The field is weakened, consequently the counter e.m.f. of the motor is reduced, and the armature will increase its speed until the counter e.m.f. is brought back to the original value, provided the resistance of the series coils is very low. If the resistance is high, the additional current taken by the armature to maintain the same torque may cause sufficient drop in the series coils to keep the speed unchanged. (2). The result of opening the shunt field depends upon the relative strengths of the shunt and series windings, and the resistance of the latter. If the series windings are relatively powerful and of very low resistance, the speed will increase somewhat. If the series field is powerful and its resistance is comparatively high, the speed of the motor will probably be reduced. If the series field is comparatively weak the speed will drop, no matter what the resistance of the series winding may be.

Does the draft tube of a water wheel remain full of water when the wheel is shut down? (2). When the wheel is running is there any vacuum in the draft tube? (3). What is the meaning of the figures on the weights of a circuit-breaker; one weight is marked 250 and all the others are marked 50? L. F. P.

If the water wheel gates and all connections were absolutely air-tight the draft tube would remain full of water when the wheel was shut down, provided it was less than 32 ft. long. In practice, however, air-tight connections are not usually obtained, so that the water in the draft tube gradually falls until the tube is empty if the wheel is shut down for any length of time. (2). For engineering purposes it can be considered that the air pressure tending to hold up the column of water within the draft tube is unbalanced by any air pressure within the draft tube. There is not a vacuum, of course, for the reason that water passes through in a continuous body and completely fills the tube. (3). The weights indicate the current at which the circuit-breaker will open when these weights are used. With the 250-ampere weight on, the breaker will open at 250 amperes; adding a 50-ampere weight will raise the opening point to 300 amperes, and so on.

THE CALDWELL WATER-TUBE BOILER.

The chief requisites in a water-tube boiler, after safety, which of course invariably comes first, are reliable and rapid circulation, together with thorough and uniform application of heat to the tube surfaces throughout the length of the tubular section; closely following these requisites are substantial joints at the headers and ease of access for cleansing purposes. That a great many attempts have been made to secure these features is amply indicated by the number of different designs of water-tube boiler now on the market. One of the most interesting of these is the Caldwell boiler, which is illustrated by the accompanying engravings.

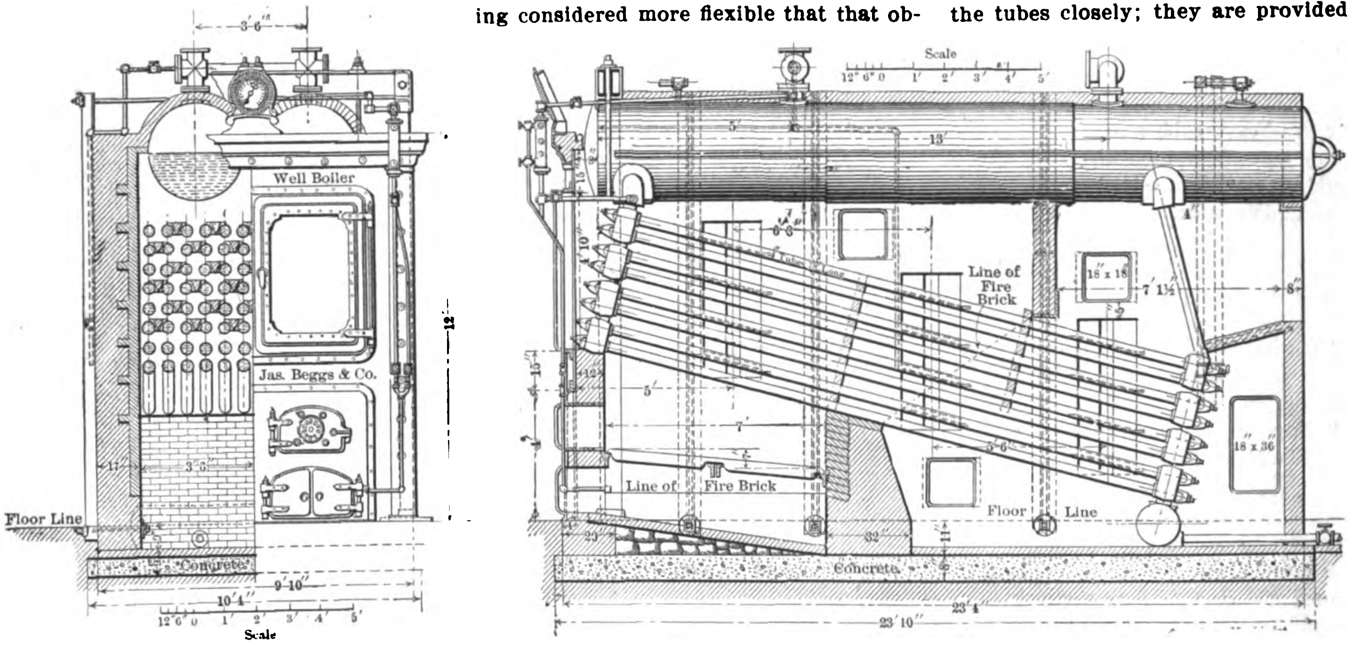


FIG. 1.—CALDWELL WATER-TUBE BOILER.—FIG. 2.

As Figs. 1 and 2 show, the boiler is of the generally familiar inclined-tube type, with the front headers opening into two horizontal drums and the back headers connected to these drums by means of practically vertical pipes known as "downcomers." The details of construction, however, differ considerably from those commonly found in this type of boiler. The tubes are made up in sections of four to a header, the centers of the holes into which the tubes are expanded forming corners of a square. The form of header used is shown by Fig. 3. This is a substantially semicubical hollow casting, into one side of which the main tubes are expanded, and in the other side of which are cored two oblong slots opposite the ends of each pair of tubes, and normally closed by hand-hole plates. The headers are connected to each other by means of small nipples of extra-heavy annealed seamless tubing, which are expanded into drilled holes of uniform diameter, this construction being considered more flexible that that obtained by means of screw joints and bushings, or ferrules.

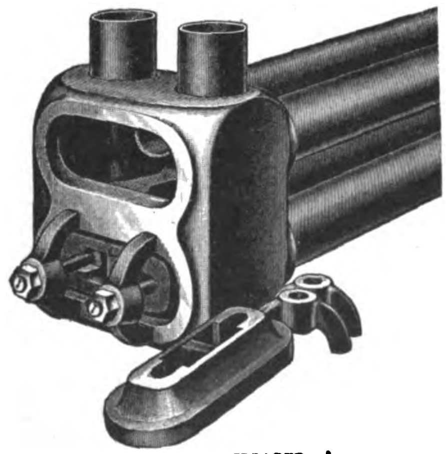


FIG. 3.—HEADER.

The baffling bricks used in this boiler are of unusual shape and arrangement. Fig. 4 shows one of these bricks between two tubes, and Fig. 5 is a cross-section of a nest of tubes, showing the way in which the baffle bricks are staggered in order to compel the gases to sweep over a maximum tube surface. This arrangement is also indicated in Fig. 1. The general course of the gases from the furnace to the chimney is similar to that in all boilers of this type, the gases first passing up between the tubes at their highest section, then down through the middle section, and up again through the rear section, so as to give a graded increase in temperature from the rear to the front ends of the tubes. The baffle bricks do not hug the sides of the tubes closely; they are provided with three ribs, as shown clearly in Fig. 4, between which there are free spaces for the circulation of hot gases. It is stated that this arrangement not only causes the baffle bricks to absorb more heat than they otherwise would, and form a sort of heat reservoir, but prevents the accumulation of dust on the tubes near the bricks, by reason of the more complete circulation of gases in this region than is usually obtained.

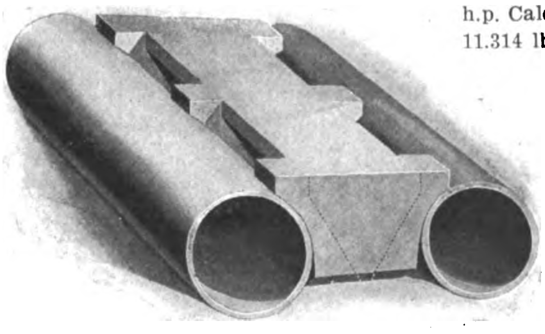


FIG. 4.—BAFFLING BRICK.

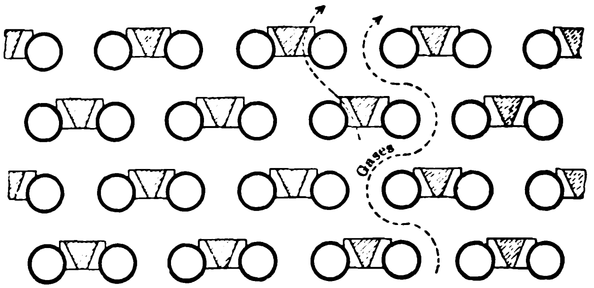


FIG. 5.—CROSS SECTION OF NEST OF TUBES.

It is stated that in a test made on a 206-h.p. Caldwell boiler by Mr. Geo. H. Barrus, 11.314 lbs. of water were evaporated from and at 212°, per pound of combustible, using Pocahontas coal, and that the boiler was made to develop 341 horse-power, or nearly 68 per cent above its rated capacity, with a natural draft of 0.47 in. of water at the rear of the boiler. A test of the steam when the boiler was being forced 65 per cent above its rated capacity is said to have shown less than 1/10 of 1 per cent of moisture, and the temperature of the escaping gases is put at 410 to 420 degrees. This boiler is marketed by Jas. Beggs & Co., New York.

New Apparatus and Appliances

NEW SERIES ALTERNATING CURRENT ARC LIGHT SYSTEM.

A new type of regulator for series alternating-current arc light circuits has been recently introduced by the Helios-Upton Company, of Philadelphia, and is shown by Fig. 1. herewith. It is essentially an impedance coil which automatically regulates its own magnetic circuit, and is arranged so that it may be placed directly upon the primary circuit without transformation if so desired. Two coils are supported horizontally on a pivot directly above them, and these are drawn up by their own attraction on an inclined U-shaped iron core to a point where their impedance will keep the current constant. The opposing force is made up largely by the weight of the coils themselves and a small weight used as an adjustment. The result is a very compact device in which the inertia of the moving parts is very small, thereby increasing the sensitiveness of the apparatus to changes of load. In connection with this regulator a differential type of lamp has been designed, employing a mechanical cut-out. When the lamp is extinguished the carbons come together so that nothing will interfere with its lighting again when the current is switched on. The lamp is shown by Fig. 2. It has four coils mounted on a central tube, the series coils being above and the shunt coils being below. These coils act on U-shaped laminated-iron cores connected through the medium of a flat spring with a clutch which lifts the carbons directly. In order to reduce the series losses to a minimum, the weight of the plungers is counter-balanced. The maker claims to have striven, not for the highest possible showing in economy and power factor, but to produce a system on whose absolute operation one might depend.

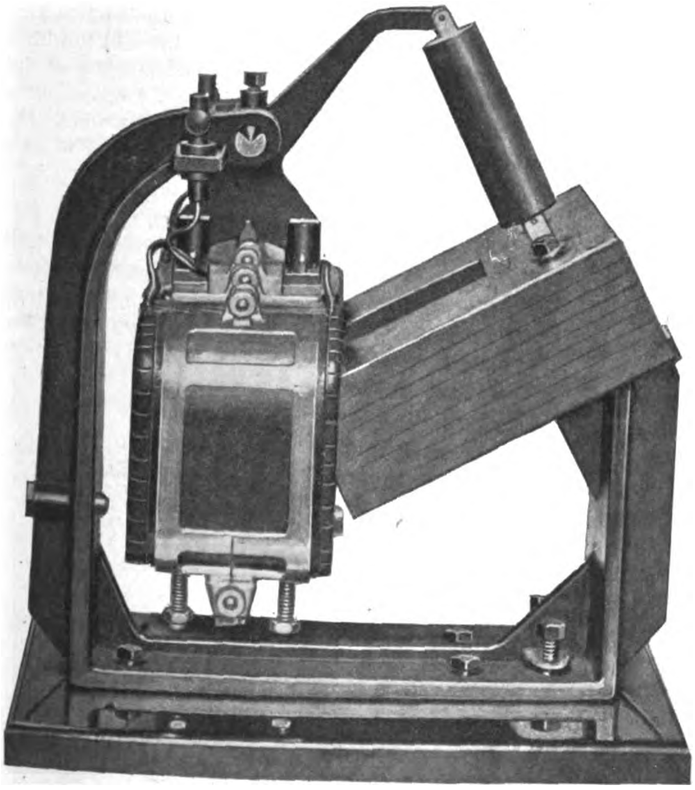


FIG. 1.—REGULATOR FOR SERIES ALTERNATING-CURRENT ARC LIGHT CIRCUITS.

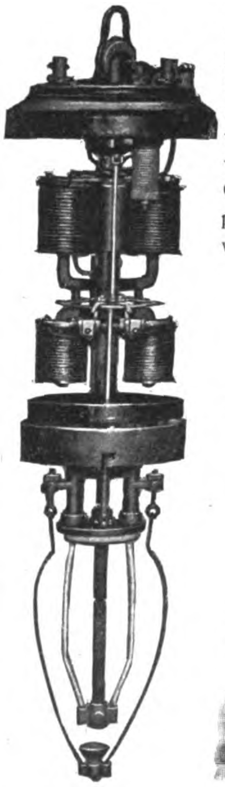


FIG. 2.—LAMP.

THE RENIM UNIVERSAL SWITCH BOX.

The accompanying engraving, Fig. 3, illustrates the Style A single switch box of the Renim Specialty Company, Boston, Mass., the feature of which is that the one form of box is available for any switch of a given type. Thus, a switch box for snap switches will take any of the standard snap switches on the market; similarly, a push-switch box will take any of the standard push switches. The convenience of this arrangement will be obvious to those who have been confronted with the question of deciding beforehand the precise make of switch to be used in connection with a wiring installation. This switch box, it is stated, may be used in the thinnest partitions, and holds flexible conduit securely in place so that it cannot be pushed back out of the box when the switch is installed. The entrance holes are drilled to the proper size instead of being cored in when the box is cast, which is another obvious advantage. For plugging the pockets that are not required, a special seal is furnished by the manufacturer of the box; but this is not indispensable, as the unused holes may be sealed by plugging them with asbestos or any other suitable material. The type of box designed for push switches will also take flush receptacles. This box has been approved by the National Board of Fire Underwriters, the Boston Board of Fire Underwriters, the New England Insurance Exchange and the Factory Mutual Fire Insurance companies of New England.

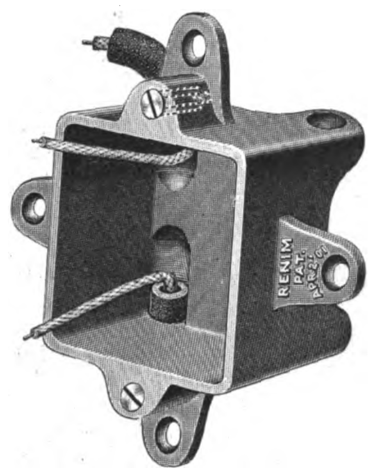


FIG. 3.—RENIM SWITCH BOX.

SIMS OIL FILTER.

As every user of machinery knows, the lubricating qualities of oil are not impaired by use; the small particles of metal and foreign matter which it accumulates through usage, however, render it unfit for further use unless these are removed. That their removal is possible is evidenced by the great number of oil filters already on the mraket. Fig. 4 herewith shows an oil filter made by the Sims Company, of Erie, Pa., in sizes ranging in capacity from two to 50 gallons per day. *A* is the receptacle for filtered oil, *B* is provided for water for filtering purposes, *E* is a receiving tank with a perforated bottom, tube and perforated conical-shaped foot, and *D* is a dish with a perforated bottom and containing a wool felt pad, *C*. The usual gauges are provided, one on each side of the apparatus, for showing the quantity of oil and water respectively. In operation *B* is filled with water to a line marked on the tank and the water brought to a temperature of 120° F. Oil is then poured into the tank, *E*, and, passing down the tube, rises through the water in drops. It then passes through a pipe into the dish, *D*, and is again filtered by the wool felt pad, *C*, and falls into the receiving tank, *A*, whence it is drawn for use. The filter is cleaned by lifting out the

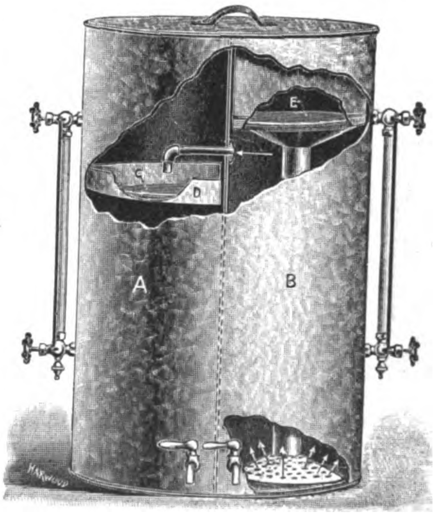


FIG. 4.—SIMS OIL FILTER.

receptacle, *E,* and running off the water from *B* when the parts requiring cleaning can be wiped off and replaced in a few minutes without disturbing the oil. Each filter is provided with a steam radiator for heating the water.

AUTOMATIC TIME SWITCH.

The necessity of having a display of lights in show windows, electric signs, etc., and the economy of having such lights burning only when needed, has created a field for a device which will automatically cut out such lights as are not needed at any predetermined time. Such a device has been designed by the O. K. Specialty Manufacturing Company, of Garrettsville, O., in the form of the time switch shown by Fig. 5, which embodies many new features and improvements. The different parts are clearly shown in the engraving. A hard drawn copper knife-blade switch is used in connection with patent spring jaws, and is said to make a perfect contact. A strong quick-break spring operates the switch when the latch which holds the blade is released by the clock. The metal parts are highly polished and mounted on an enameled slate base.

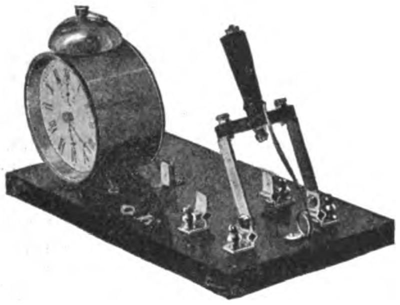


FIG. 5.—AUTOMATIC TIME SWITCH.

FRANCE METALLIC PACKING.

The accompanying illustrations show a few of the many forms of metallic packing made by A. W. France, of Philadelphia. The parts are all lettered and numbered and are easily put in place, the lettered side of the rings facing toward the pressure, and corresponding with the letters opposite grooves on the case. Ample space is provided to allow the rings to move, should the rod be out of alignment or vibrate. Fig. 6 shows a pair of packing rings cut in three sections. The cuts making the faces of contact are made in the lines of an equilateral triangle whose center coincides with the center of the rod; so that the relationship between the surfaces of contact is maintained despite irregularities in the diameter of the rod. Fig. 7 shows the outside packing used for both piston rods and valve stems, where the stuffing box will not admit of an inside packing, and Fig. 8 is a cross-sectional view of the same. Referring to the illustration, it will be noticed that the packing is mounted in a case, which takes the place of the gland. This construction admits of a deep ring, which is said to give a much longer life than if the packing were made to fit in the stuffing box, especially where the latter will not take ⅝-in. or larger fibrous packing.

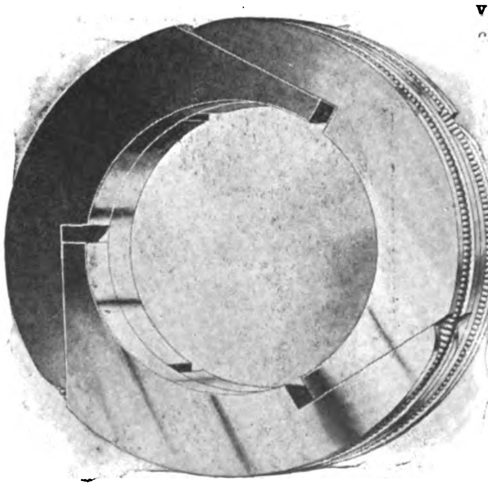


FIG. 6.—PAIR OF PACKING RINGS.

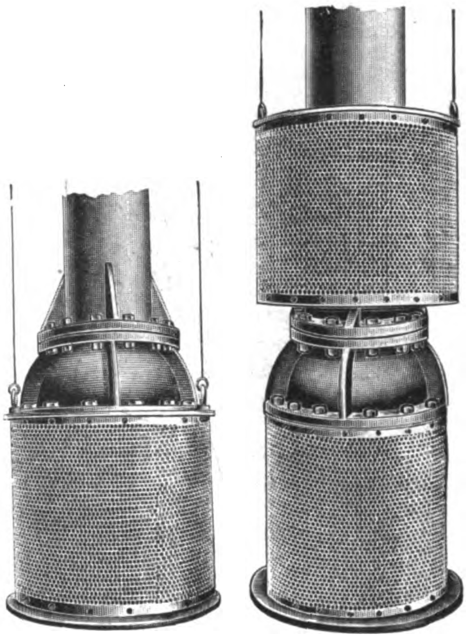


FIG. 9.—CONTINUOUS SERVICE FOOT-VALVE.

CONTINUOUS SERVICE FOOT-VALVE.

The foot-valve shown by Fig. 9 was designed with a view of automatically obviating, as nearly as possible, the trouble caused by the entry of solids into the pipes of water systems. It consists of the combination of a foot-valve with a set of tubular screens, the smaller one of which is attached to the foot-valve proper. The larger, or outer screen, is provided with knives or scrapers, and is so arranged that it can be raised above the water line and cleansed without disconnecting the valve or stopping any part of the plant. In order to raise it, ropes or chains are attached to the screw eyes, as shown. Fig. 10 is a sectional view, showing the arrangement of a valve with the suction pipe extending below the valve, and the inner and outer screens, with knives or scrapers attached to the latter. From this it will be seen that as the outer screen is lowered into position the knives attached to it at the top and bottom scrape over the outer surface of the inner screen and cleanse it. By means of the suction pipe extension, the suction is brought to within a few inches of the bottom plate of the valve, thereby providing for operation in shallow water. The valve is made by the Newman Manufacturing Company of New York.

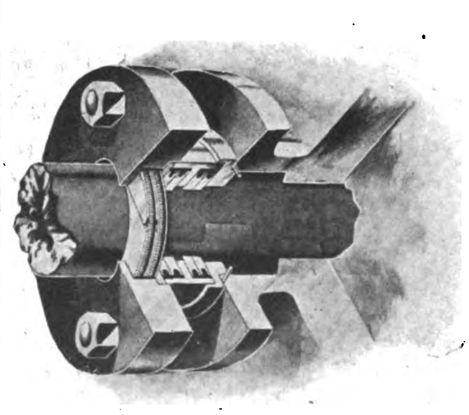


FIG. 7.—OUTSIDE PACKING.

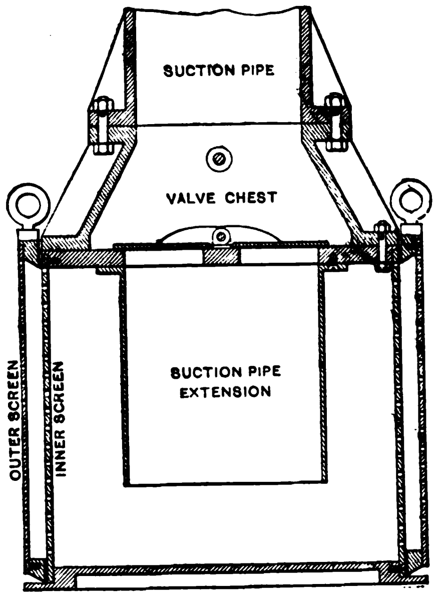


FIG. 10.—CROSS-SECTION OF FOOT-VALVE.

FRICTION SENSITIVE DRILL.

There is hardly a machine in the metal-working line where the speed of the working tool changes in shorter intervals than the sensitive drill. It is, therefore, of importance to have the speed-controlling medium instantaneous and precise. In the drill shown by Fig. 11, the driving mechanism consists of two cones and a friction roller. The power is transmitted from

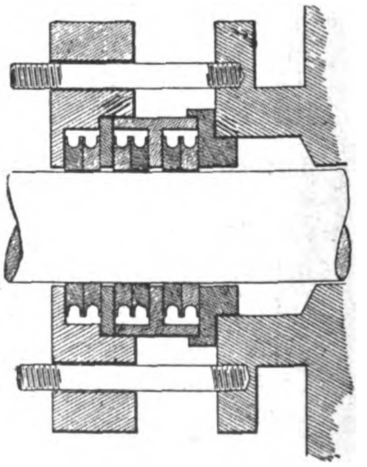


FIG. 8.—CROSS-SECTION OF OUTSIDE PACKING.

the lower cone to the friction roller, which transfers the power to the upper, or spindle cone. The speed of the drill spindle is thereby increased or diminished without stopping the machine or shifting belts, by simply sliding a frame upon which is mounted the friction roller. On the slide guiding the friction roller are graduations showing the position in which to place the roller to obtain the proper speeds to drill the metal to the best advantage. There are also graduations on the sleeve passing through the spindle head indicating the depth to be drilled; and an adjustable stop-collar is provided on the sleeve which can be set so that any number of holes of a given depth can be drilled without referring to the graduation on the sleeve. The driving pulleys are enclosed in a frame which is adjustable on the column, and a neat contrivance provides a means whereby the desired belt tension may be secured instantly. Each machine is provided with an endless belt, insuring smooth and steady driving power, absence of vibration, and no trouble from lacing. The attachments furnished with the machine, and shown in the engraving, are a cup center, used in drilling holes in the ends of shafts, mandrels, etc.; a center point, for supporting the work when one center has been drilled; a V-block, with stem, used for supporting shafts to be drilled at right angles to their axis, and a supplemental V-block for drilling holes eccentrically in preparation for turning shafts eccentrically in the lathe. The drill press is made by the Knecht Brothers Company, Cincinnati, Ohio.

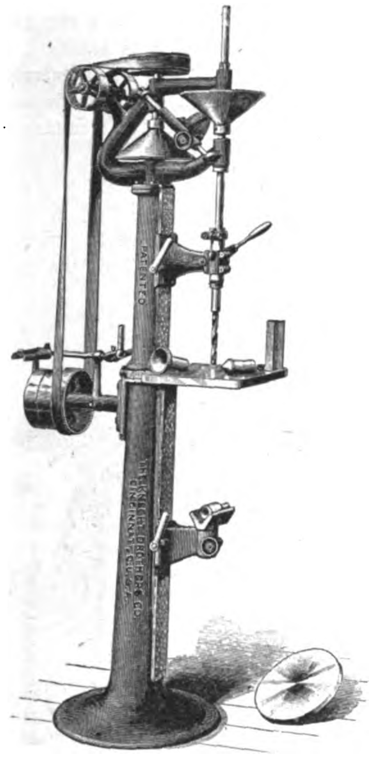


FIG. 11.—FRICTION SENSITIVE DRILL.

IMPROVED DIRECT READING OHMMETER.

The direct reading ohmmeter shown by Fig. 12 is intended for practical testing and as a companion to the portable ammeter and voltmeter. It is made by F. B. Sage & Bro., of New York, and is an improved form of the instrument that has been on the market for several years. The instrument is a modified form of the Wheatstone slide wire bridge, two arms of the bridge being formed by the slide wire, and the third and fourth by the known and unknown resistances respectively. The unknown resistance being in circuit, a suitable known resistance is plugged in and a point sought for on the wire with a stylus where no sound is heard in the telephone receiver, which is in series with the indicating circuit. The energy is supplied by a battery in the lower part of the case, and the battery is placed in circuit by a key, *K*, shown on the telephone receiver, and is automatically disconnected when the receiver is replaced. There are four known resistances provided, any one of which may be put in circuit by using a single plug. Four sets of readings are thus possible on the slide wire, giving the instrument a range from 0.001 ohm to 200,000 ohms. Attention is directed to the contact plug, which is connected with a stout flexible cord and fits in a metal socket reamed to accurately fit the plug. But one friction contact is in series with the plug circuit instead of two, as is ordinarily the case, so that no special care need be exercised in manipulating the plug. Moreover, there is but one plug contact in the entire bridge circuit so that errors resulting from a multiplicity of plugs are avoided. The scale of the ohmmeter is engine divided, and the wire is said to be absolutely uniform in resistance and cross section, which feature, although it appears to be easy to provide, is on the contrary, quite a problem.

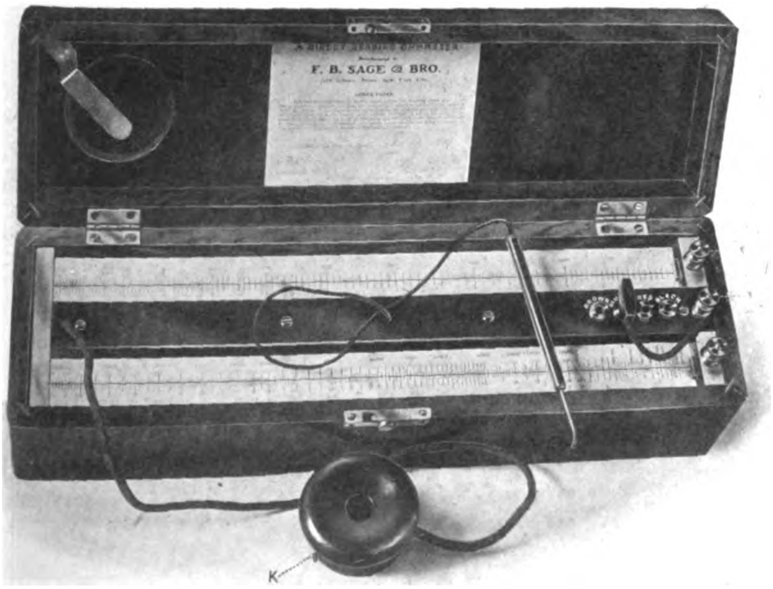


FIG. 12.—DIRECT READING OHMMETER.

HIGH PRESSURE NON-RETURN STEAM TRAP.

The high-pressure non-return steam trap made by the Albany Steam Trap Company, of Albany, N. Y., and shown in section by Fig. 13, differs from other steam traps in that the area of the discharge valve is very large, the object being to reduce as much as possible the friction of the water passing through the valve opening. The outlet proper is in the center of a thin disc placed in the body of the discharge valve outside of the discharge-valve seat, so that instead of the rapid wearing away of the valve and its seat, it is this small disc that is subjected to the wearing friction, and when worn is easily replaced. The illustration shows a vertical cross-section through receiving and discharge pipes and valves. Referring to the figure, it will be seen that the condensed water enters the trap through the inlet valve, *A*, and is forced through the perforated strainer, *B*, into the small chamber, *D*. It then fills the space between the bucket and the outer shell, floating the bucket, which, in rising, presses the valve, *H*, against its seat, *K*, through the medium of the lever, *N*. The bucket now being in its highest position, the water rising will overflow into it. When the bucket is finally full of water it drops to its original position,

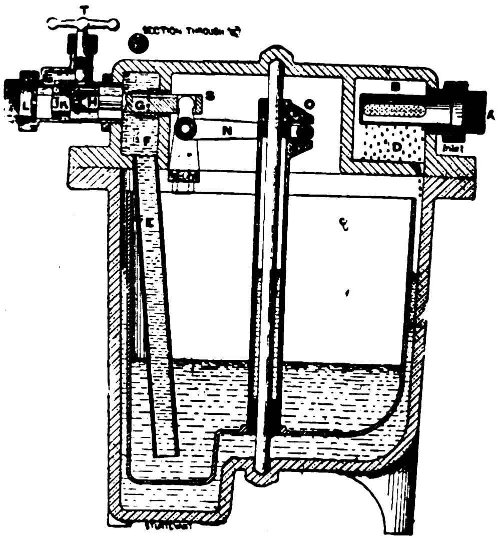


FIG. 13.—CROSS-SECTION OF STEAM TRAP.

opening the discharge valve to its fullest extent, and the water is then forced out of the bucket through the discharge pipe, *E*, into the chamber, *F*, through the valve seat, *K*, and finally through the disc, *L*, by the pressure of steam behind it. A small groove is provided in the valve stem, *G*, which permits air to enter the chamber, *M*, and escape by opening the valve, *T*, in case the trap should become air-bound. The trap, which is known as "Class B," is especially adapted for use on steam-jacketed cylinders, separators, pipes, and all classes of drying and evaporating apparatus using steam pressures over 100 lbs. All of the parts are interchangeable.

AUTOMATIC MAGNETIC CIRCUIT-BREAKER.

Fig. 14, herewith, shows an automatic magnetic circuit-breaker made by the General Incandescent Arc Light Company, of New York. It is of the double-pole type, with each side of the circuit independent, the latches being separate and closed separately. If an overload exists, it is impossible to close the circuit, since the first side to be closed will open when the second side is closed. The contacts are of the laminated type, protected from arcing by three metal shunts, one opening after the other, and a final carbon break of great length. The magnetic portion of the circuit-breaker consists of a solenoid capable of taking a large overload, and a movable core of soft iron. Roller latches made of hardened steel, and interchangeable, are provided in all of the circuit-breakers, so as to eliminate friction as much as possible. The opening spring, which controls the laminated contacts and the carbon carrier levers, operates until the carbons are free and open. A glance at the engraving shows that the circuit-breaker is made heavy and substantial, for constant and rough usage. The moving parts are all provided with machined bearings, and are interchangeable. The laminated contacts may be readily taken out for inspection, and their weight does not drag on the moving parts. On the larger size a toggle joint is provided for closing the breaker. The apparatus is finished in polished copper, and is calibrated, tested and inspected before shipment; it is made for direct or alternating current.

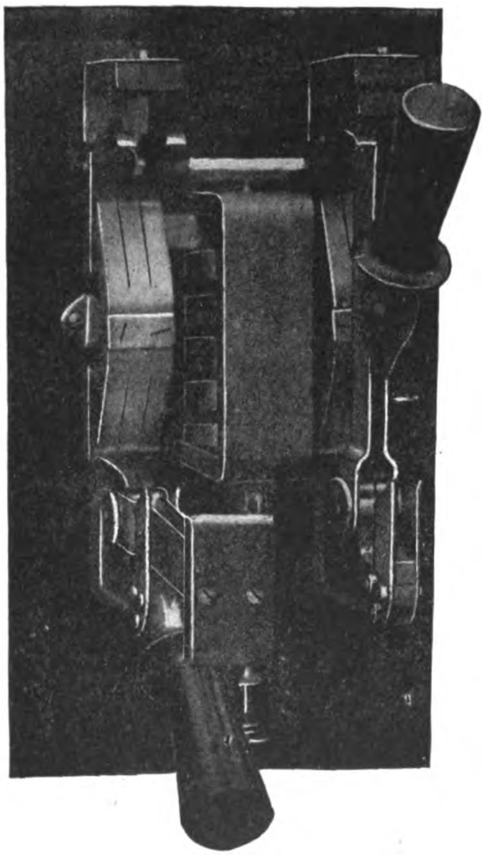


FIG. 14.—MAGNETIC CIRCUIT-BREAKER.

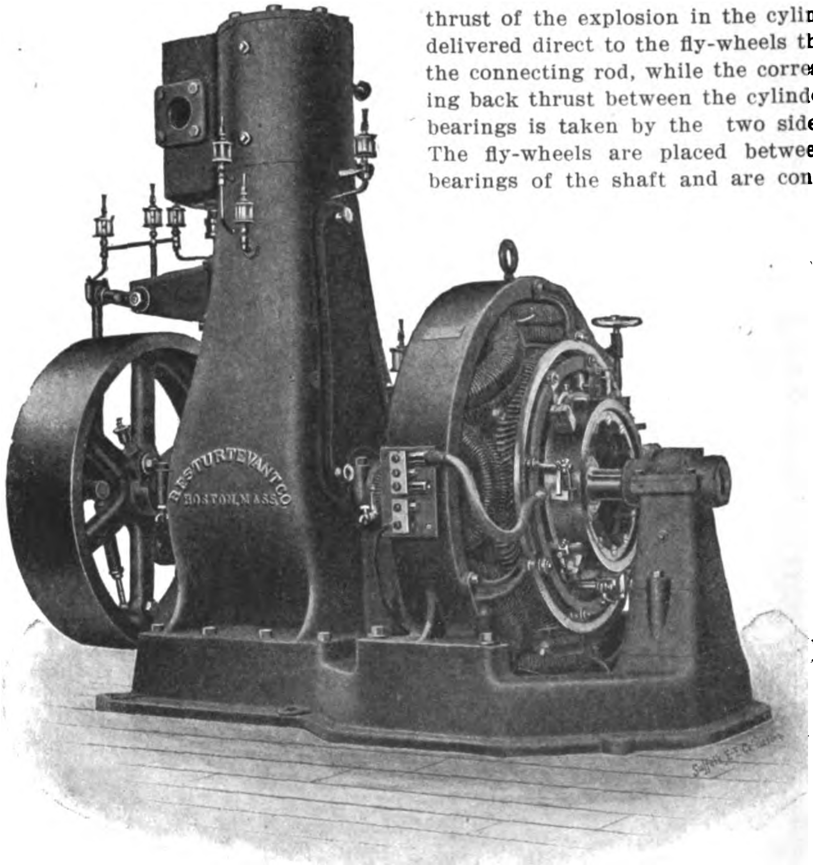


FIG. 15.—DIRECT-CONNECTED GENERATING SET.

DIRECT-CONNECTED GENERATING SET.

Fig. 15, herewith, shows a new design of generating set by the B. F. Sturtevant Company, of Boston, Mass. The engine is of the single cylinder vertical type, the frame and cylinder being cast in one piece. High pressure engines of this type are built in seven sizes and designed for 90 lbs. boiler pressure. A similar line of four sizes is also designed for 40 lbs. pressure. The valve is of the balanced piston type, and receives its motion through a rocker-arm from a pin on the governor weight. This weight is so pivoted to the wheel that any change in its position causes the pin to swing across the shaft. This movement changes the travel of the valve and regulates the points of cut-off and compression, the former being between zero and seven-eighths of the stroke. The generator is of the eight-pole type and originally designed as a motor for direct connection to centrifugal fans. Wrought iron field cores are used in all but the smallest size, and are bolted to the frame. In the smallest size the field cores are cast solid to the frame and the pole shoes only are removable. The armature is of the barrel-wound, toothed, hollow drum type, mounted on a cast iron spider, the hub of which is extended to support the commutator. The generator has ample ventilation and the rise in temperature is thereby reduced to a minimum.

FRANKLIN GAS ENGINE.

The gas engine shown by Fig. 16 is intended for those who desire to construct their own engines, and all of the parts except the fly-wheels and bed plate can be finished on an 8-in. lathe. The engine has a cylinder and piston shell of seamless drawn-steel tubing, and the thrust of the explosion in the cylinder is delivered direct to the fly-wheels through the connecting rod, while the corresponding back thrust between the cylinder and bearings is taken by the two side rods. The fly-wheels are placed between the bearings of the shaft and are connected together by the crank-pin. Parsell & Weed, of New York, furnish the engine complete; or to those who wish to construct it themselves, the complete set of castings and full-sized detail blue-

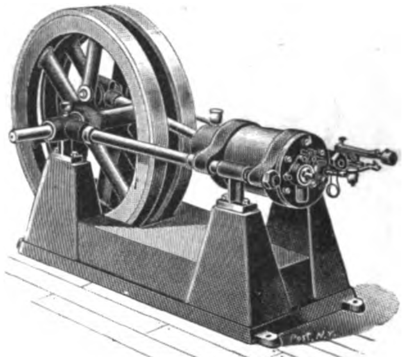


FIG. 16.—FRANKLIN GAS ENGINE.

prints, with all dimensions given. The castings are molded from soft, easy-working metal, and the fly-wheels, main bearings and piston, together with inlet and exhaust-valve casings, have holes cored in them, and only require boring and reaming to size. The engine develops one-half horse-power.

LONG NOSE PLIERS.

The Smith & Hemenway Company, of New York, is offering as their latest development in pliers the pair shown by Fig. 17. These are of the side-cutting type having a long and narrow nose, making them of service in deep, narrow quarters where the ordinary tool would be of little use. They are convenient to carry, and are especially adapted for the uses of linemen, machinists, engineers and electricians.

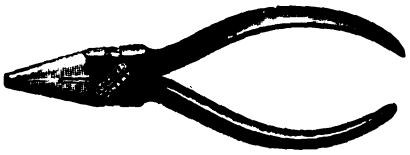


FIG. 17.—LONG NOSE PLIERS.

IMPROVED X-RAY APPARATUS.

The accompanying illustrations represent recent forms of Roentgen ray apparatus brought out by Elmer G. Willyoung, of New York. Fig. 18 shows a portable X-ray coil which has a short iron core with a very large cross-section; this permits of a rapid rate of interruption and gives very "fat" sparks. The induction coil is in the larger box; there is a pair of adjustable balls constituting the parallel spark gap and on each side of the secondary is another adjustable ball, forming a series gap for each terminal. If desired the coil may be connected direct to a lighting circuit and run with either the Caldwell or Wehnelt interrupter; or it may be run with the portable interrupter shown in the engraving, on a few cells of battery. With a suitable rheostat this portable interrupter will run the coil on a lighting circuit. These coils are very compact and are ready for transit when the lids of the cores are closed. Fig. 20 shows another form of portable coil intended for general experimental purposes and especially for use on lighting circuits with electrolytic interrupters; this coil is known as "Model Q." The secondary terminals are brought out to a pair of insulated binding posts on top of the box and the primary terminals are taken out at one end to a double-throw circuit and reversing switch.

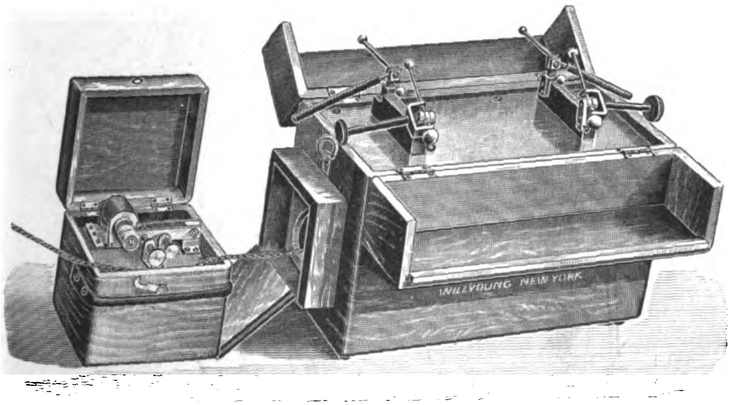


FIG. 18.—PORTABLE X-RAY COIL.

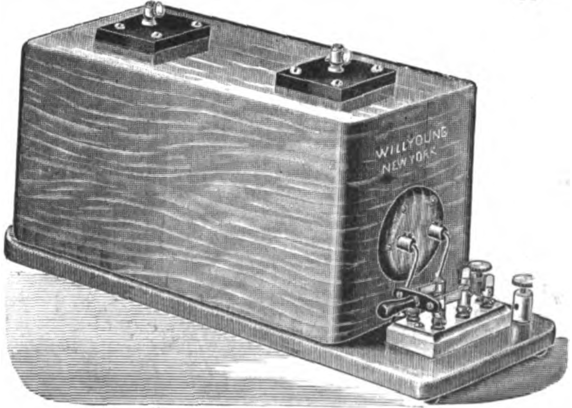


FIG. 20.—"MODEL Q" PORTABLE COIL.

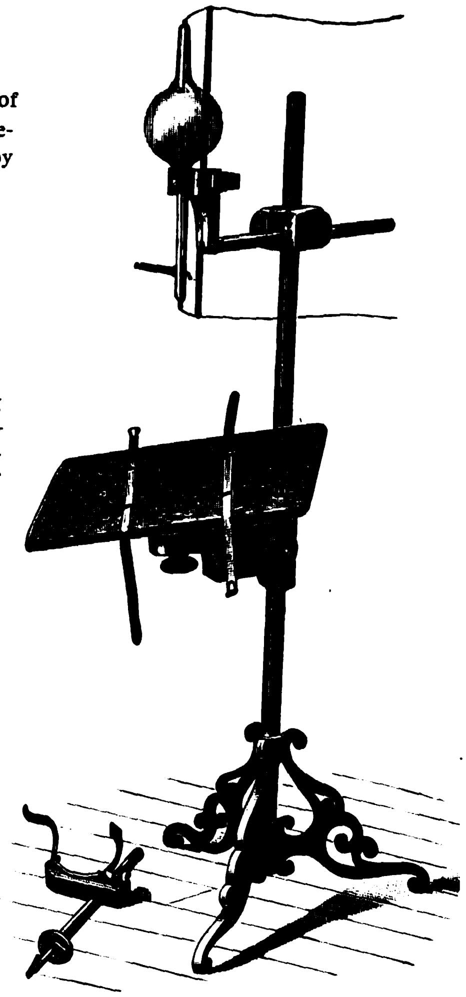


FIG. 19.—CALDWELL TUBE AND RADIOGRAPHIC STAND.

Fig. 19 shows the Caldwell tube and radiographic stand. This stand is constructed almost entirely of wood. There are no pivoted joints and consequently no slip; the tube clamp proper is a spring device, which opens by pinching, and automatically catches the tube in a firm but gentle grip when released. As an extra attachment to this stand is a small table, 11 ins. by 18 ins., mounted on a ball and socket joint, adjustable vertically and in any plane, and instantly removable from the stand. In radiographing the limbs, the table is used as a support for the subject member, being readily adjustable to a comfortable position. Spring clips carrying straps fit into holes bored into this table and hold the limbs in position.

P-K FIELDING RECEPTACLE.

Construction men who have been compelled by conditions over which they had no control to stick a 3-inch or 4-inch lamp receptacle in a line of molding 2 inches wide, will appreciate the convenience of a new type of receptacle that has been put on the market by the H. T. Paiste Company, Philadelphia, Pa., and is illustrated by Figs. 21 and 22 herewith.

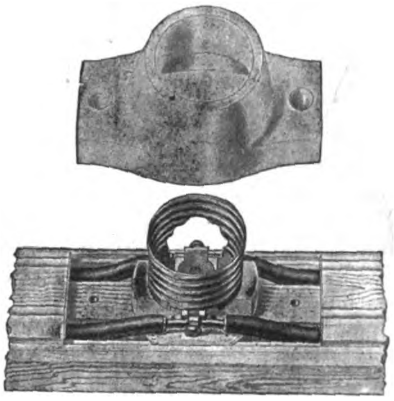


FIG. 21.—LAMP RECEPTACLE.

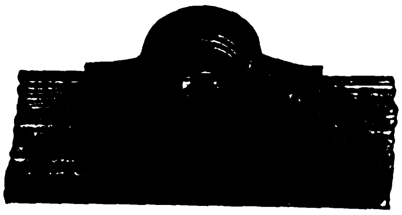


FIG. 22.—LAMP RECEPTACLE.

The illustrations are practically self-explanatory. The socket part of the receptacle is put in place on the molding with the wires passing through the clips, and the porcelain block is then screwed down over the top of the receptacle, as shown in Fig. 21. The advantages of this little appliance are unmistakable. The wire does not have to be cut, the molding base need not be cut, there are no connections left bare, and the finished job is symmetrical and workman-like in appearance.

AUTOMATIC OIL PUMP.

The Mangel sight-feed automatic oil pump illustrated herewith was designed by Mangel Bros., of Buffalo, N. Y., for the reliable and economic lubrication of the cylinders of steam and gas engines and steam pumps. They are made in sizes having varying capacities ranging from 1/3 pint to 1 gallon, with one, two, three, four, five and six feeds. All of the pumps have a hand attachment on the driving wheel, so that the pump may be worked independently before the engine is started, or momentarily if more oil is needed. The driving mechanism consists of a drop-forged steel wheel rigidly mounted on a shaft, having a steel clutch block, with a steel ball traveling in a groove on the inner circumference of the wheel; a spring holding the ball in position on the wedge seat in the clutch block. A ball brake is used to hold the crank shaft during the return stroke, so that the wheel can only turn one way. The method of feeding is very simple: The return stroke of the plunger forms a vacuum or suction which draws the oil into the pump cylinder, and the forward stroke forces the oil through check valves into the steam cylinder. The weight of the oil in the cup is balanced by the valve stem, which stops the flow of oil when the engine is at rest. The advantages claimed by the manufacturers are that the pump is noiseless in operation, the sight feed is free from steam or water, and there is no pressure on the sight glass or reservoir.

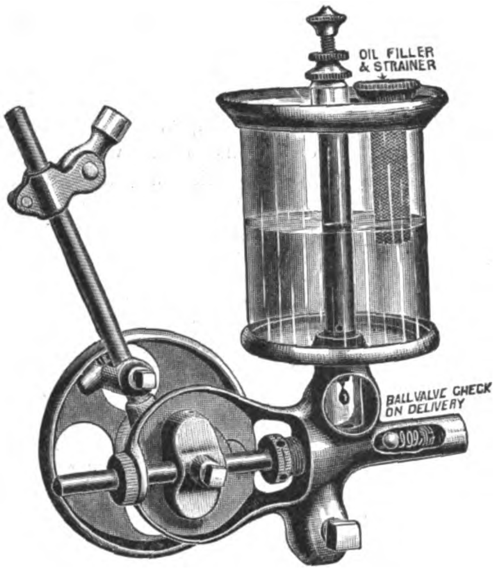

OIL FILLER & STRAINER
BALL VALVE CHECK ON DELIVERY

FIG. 23.—SINGLE FEED OIL PUMP.

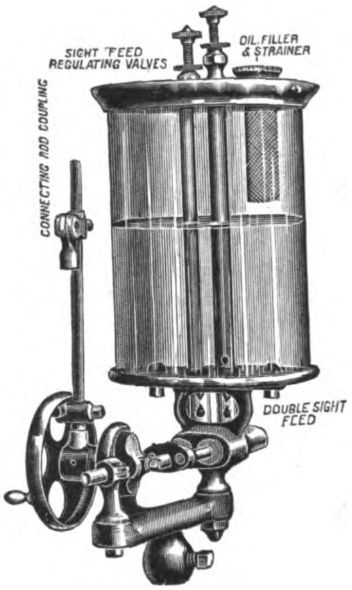


FIG. 24.—DOUBLE FEED OIL PUMP.

THE BOSTON CABLE CLIP.

Fig. 25, herewith, shows the Boston cable clip made by the Chase-Shawmut Company of Boston, Mass. Reference to Fig. 26 shows how very simple it is both in form and application. It consists of two pieces of steel wire and a strap of sheet metal, and can be quickly and easily adjusted to any cable that the strap will go around. It is adjusted wholly by hand, and is fitted in this way very firmly. *A*, *B*, *C* and *D*, Fig. 26, show the different steps in the adjustment. The metal strap is simply pulled tightly around the cable before it is passed through the hanger, as shown by *B*. Upon turning over the hanger the metal strap is bent down, as shown by *C*, and locked into place; the lever action taking in all slack and binding the strap tight. *D* shows the strap in its final form. The advantages claimed for the clip are that on long stretches where the dip is great, the clip will not slide on the cable, but stay where it is placed; in hanging cables it is not necessary to pull them taut and then put on the clips by means of ladders or hanging baskets; the clip described may be adjusted before the cable is pulled up, as the hooks will slide easily on the guy.

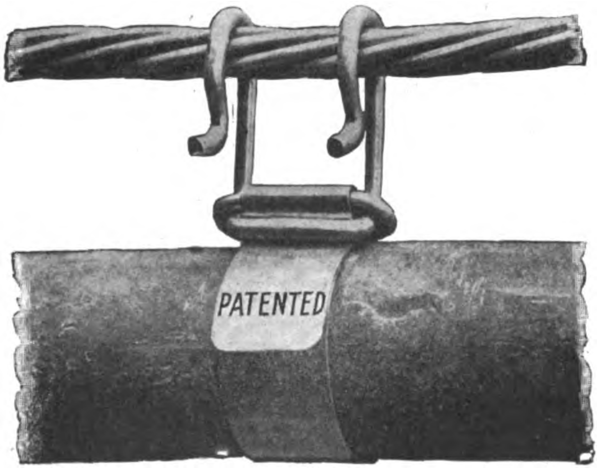


FIG. 25.—BOSTON CABLE CLIP.

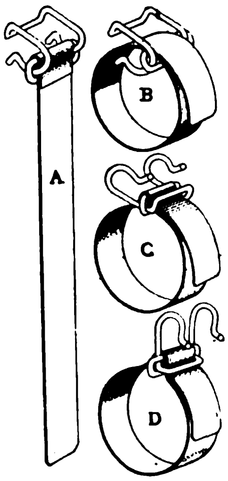


FIG. 26.

STEAM SEPARATOR FOR THE INTERIOR OF BOILERS.

The steam separator shown in the accompanying illustrations was designed by J. T. Lindstrom of Allentown, Pa., to be located in the interior of a boiler in order to prevent water and impurities from entering the steam pipe and to thus supplement the separator near the engine. As shown by Fig. 29, the small holes in the upper surface of the separator, and the webs under each hole, prevent the sudden and direct withdrawal of steam, which is compelled to take a circuitous path; and the water, being separated in much the same way as in the familiar form of separator, flows back into the boiler through a suitable opening in the bottom, which is connected with a pipe leading down below the water-line of the boiler. Reference to Fig. 28 shows that the appliance is made in one piece, and that there are no parts which are liable to become disarranged. In applying it to a boiler it is only necessary to drill two holes and tap for ⅝-in. stud bolts, which are furnished with the separator.

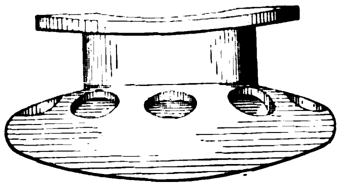


FIG. 27.—SEPARATOR.

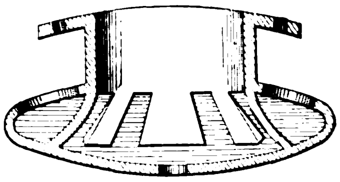


FIG. 28.—CROSS-SECTION OF SEPARATOR.

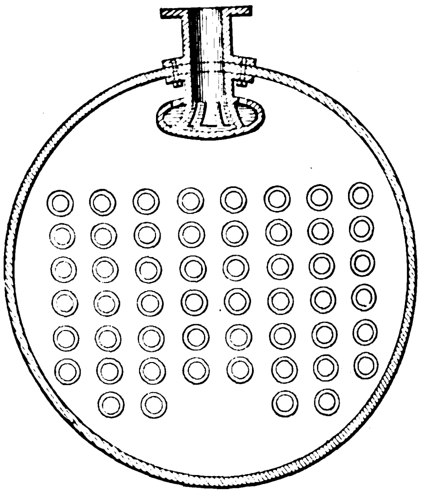


FIG. 29.—BOILER WITH SEPARATOR ATTACHED.

NEW BOOKS.

How to Build a Three Horse-Power Launch Engine. By E. W. Roberts. Cincinnati, Ohio: The Gas Engine Publishing Company. Cloth; 66 + vi pages, 10 x 13 ins.; 14 full-page plates of drawings. Price, $2.50; with blue prints, $6.50.

This is a complete set of working drawings and instructions for building a four-cycle gasoline engine and an 18-in. three-blade bronze screw propeller for a launch 24 ft. long. The instructions are explicit, and the drawings are complete to the last detail. Blue prints, made from the original drawings, which are mostly full size, accompany the book when so ordered.

How to Become a Good Mechanic. By John Phin. New York: Industrial Publication Company. Paper; 68 pages, 5 × 7½ ins. No illustrations. Price, 25 cents.

This little book contains most wholesome advice for young men, and can scarcely fail to be of much value to anyone who is trying to succeed unaided by a complete education. The author indicates what such a worker should study, and emphasizes the importance to an aspiring mechanic of mathematical knowledge. The present edition is the second, the first edition having been out of print for some time. The book has been almost entirely rewritten, and considerably expanded.

Practical Applications of Electrical Waves. (Les Applications Practiques des Ondes Electriques.) By Albert Turpain, Sc. D. Paris: C. Naud. Paper; 414 pages, 5½ x 9 ins.; 271 illustrations. Price, 12 francs; in America, $3.60.

This is a splendid résumé of the work that has been thus far accomplished in the field of electric oscillations, beginning with the experiments of Hertz and following the progress in the science down to the work of Marconi, Lodge, Slaby, Arco, Tesla and Orling, the recent developments being covered as far as the early part of 1901. The work is devoted principally to wireless telegraphy, of course, this being the chief "practical applications of electric waves" thus far developed. The illustrations show the various forms of instruments that have been devised, and diagrams of connections as used by the several investigators are given. The book closes with a list of French, German, English and American patents issued up to the end of 1900.

Compressed Air. By Gardner D. Hiscox. New York: Norman W. Henley & Co. Cloth or half morocco; 820 pages, 6 × 10 ins.; 545 illustrations. Price, cloth, $5; half morocco, $6.50.

This is an interesting collection of data relating to compressed air and its application to industrial purposes, and although a compilation, it has the very useful function of a reference book of general information within its titular scope. The contents include a presentation of the physical properties of free and compressed air, with tables of specific volumes and weights at different temperatures, or conversely; together with descriptions of the principal—in fact, nearly all—types of machinery operated by, and handling, air. The author appears to be still fascinated by the liquid air problem, having devoted a chapter to this subject. The size of the book precludes anything like a detailed review; it may suffice to say that it can scarcely fail to be of value to anyone interested in air-handling or air-driven apparatus.

Practical Method of Calculating Polyphase Induction Motors (Methode Practique pour Calculer les Moteurs Asynchrones Polyphasés). By Boy de la Tour. Paris: Ch. Béranger. Cloth; 216 + viii pages, 6 x 9½ ins.; 70 illustrations. Price, 12½ francs; in Americas, $3.75.

M. de la Tour, who is chief engineer of one of the prominent manufacturing establishments of France, has succeeded admirably in his effort to present in comprehensible form the principles of induction motor design. The rotating magnetic field is explained in the opening chapter, together with the principles of stator winding; in the succeeding chapters are discussed the induction of e.m.f. by the rotating field; rotor windings; magnetizing of short-circuiting rings in a squirrel-cage rotor; operation of polyphase motors, and the practical application of these motors. The book is well written, and although mathematics abound, the expressions are relatively simple and are used only to demonstrate deductions which are stated in plain language, in contradistinction to the abominable habit of most mathematicians of stating a proposition only in formula shape.

OBITUARY.

THOMAS DICKENSON BOYLES died recently at Schenectady after a brief illness. Mr. Boyles was a prominent member of the engineering staff of the General Electric Company, having held an extremely responsible position in the switchboard department of that company for several years. He was associated with nearly all of the great switchboard problems handled by the General Electric Company during the past five years, notable among which were the switchboards of the Metropolitan and Manhattan Railway companies, that of the New York Gas & Electric Company, and important and difficult parts of the Niagara Falls switchboard equipment.

PERSONAL.

MR. D. C. LIGHT, of Milwaukee, Wis., has been appointed superintendent of the Waukegan (Ill.) Electric Light Company.

MR. H. S. KEMP, who was formerly connected with the Boston street railway system, has been appointed chief electrician of the Richmond Passenger & Power Company, Richmond, Va.

MR. JOHN COSTIGAN, manager of the electric light plant at Cloquet, Minn., was married recently to Miss Nellie Merrick, of Blue Earth, Minn.

MR. EDWARD S. BOSWORTH, owner of the electric light plant at Le Roy, Mich., was married recently to Miss Elizabeth J. Powell, of the same place.

MR. WILLIAM A. ROSENBAUM, the well-known patent attorney, has removed his office from the Times Building, New York, to the Nassau-Beekman Building, 140 Nassau Street.

MR. FRANK MOFFATT, who was for some time city electrician of Dallas, Tex., has been appointed to the same position in the city of Manila, Philippine Islands.

MR. PHILIP DAWSON has severed his connection with Robert W. Blackwell & Company, Limited, London, to engage in consulting engineering practice. Mr. Dawson's new headquarters are at Lennox House, Norfolk Street, London.

MR. U. N. BETHELL, general manager of the New York Telephone Company, has been elected president and general manager of the Chesapeake & Potomac Telephone Company, with headquarters in Baltimore. The Baltimore company is to be congratulated.

MR. HENRY C. PAYNE, vice-president of the Milwaukee Electric Railway & Light Company, and a past-president of the American Street Railway Association, has been appointed United States Postmaster General by President Roosevelt, to succeed Mr. Chas. Emory Smith.

MR. JAMES F. CUMMINGS, the London representative of the American Vitrified Conduit Company, who has been spending some time in this country, has returned to Europe and will proceed immediately to Russia to look after an important contract at St. Petersburg which his company has secured.

MR. LOUIS R. ALBERGER, for several years prominently connected with the condenser department of the Henry R. Worthington Company, has formed the Alberger Condenser Company, of which he is the president. Messrs. B. W. Pierson, D. H. Chester and Geo. P. Symonds, who were also connected with the Worthington Company, are associated with Mr. Alberger in his new company.

MR. J. S. WEBSTER, formerly northwestern agent for the Walker Company, Cleveland, Ohio, and for six years engaged in the design, manufacture and installation of a variety of electrical apparatus, has been appointed manager of the Wausau Quartz Company, of Wausau, Wis. This company operates the only quartz mill in the Middle West and receives many orders for filtration quartz for steam, power and water supply plants.

MR. A. P. JENKS, who has for some time past been associated with the publication department of the General Electric Company at the New York office, was recently promoted to a responsible position in the railway engineering department of that company at Schenectady. While Mr. Jenks' friends among the electrical fraternity in New York greatly regret his removal from the city, they all congratulate him upon his promotion.

MR. FRANCIS H. SHEPARD, who has made many friends in his capacity as assistant to Mr. Frank J. Sprague in the railway department of the Sprague Electric Company, has resigned his position with that company to accept a very important post with an English syndicate formed for the purpose of carrying on important work in heavy electric traction in England. Mr. Shepard has just returned from a visit to England and will go back to that country in February.

MR. MORRIS W. MEAD has been reappointed chief of the municipal electrical bureau of Pittsburg, Pa. Mr. Mead held this position for several years until a few months ago, when an upheaval in local politics caused a change in the city administration and he was removed with the outgoing city officials. For some time Mr. Mead's old position at the head of the bureau was vacant, no competent man being found to take the position. The status of political affairs has again been reversed, with the result that Mr. Mead is reinstated, to the conspicuous advantage of the city.

TRADE PUBLICATIONS.

CALENDAR. N. W. Ayer & Son, Philadelphia, Pa.—A calendar of extra large size containing at the top an artistic advertisement of the Ayer firm.

CALENDAR. The Ashton Valve Company, Boston, Mass.—A calendar for 1902, consisting of the usual monthly leaf pad mounted on a handsomely illustrated cardboard backing.

PRACTICAL ECONOMY. Doubleday-Hill Electric Company Pittsburg, Pa.—A pocket-size pamphlet in which are presented some interesting arguments concerning the winding and repair department of the Doubleday-Hill shops.

APPLICATIONS OF CHLORIDE ACCUMULATORS. The Electric Storage Battery Company.—A large pamphlet in which are illustrated various applications of chloride accumulators to lighting, power and street railway service.

BRUSH ARC GENERATORS. General Electric Company.—This is bulletin No. 4268, containing an elaborately illustrated description of the well-known Brush arc-light dynamo as at present manufactured by the General Electric Company.

WILLIAMS ENGINES. Quincy Engine Works, Quincy, Ill.—This is a catalogue of Williams' horizontal and vertical engines, containing tabulated data relating to these engines. The book is not illustrated, but it is executed in conspicuously good taste.

CRANES and CONVEYORS. Putnam & Co., New York.—This is the 1902 catalogue of this firm, in which are illustrated and described the various forms of conveyors, trolleys, cranes and other similar appliances traveling on overhead tracks.

ANNUAL HANDBOOK. American School of Correspondence, Boston, Mass.—This is the 1901 handbook of this well-known institution, in which the methods of the school are described in detail, and synopsis of its full and special engineering courses are presented.

RECORDING THERMOMETERS.—The Bristol Company, Waterbury, Conn.—Circular No. 6T, devoted to Bristol recording thermometers, the recording mechanism of which is made on the same general plan as in the well-known Bristol recording voltmeters and ammeters.

CHAIN-GRATE STOKERS. The Playford Stoker Company Cleveland, Ohio.—A pamphlet catalogue of large size containing an illustrated description of the Playford chain-grate stoker, together with illustrations of some typical equipments put in by the company.

LITTLE GEM ROSETTES. Pass & Seymour, Inc., Solvay, N. Y.—A pocket-syize catalogue of these well-known rosettes, which are made for all classes of wiring. The catalogue, though small, is handsomely executed and effectively illustrated with half-tone engravings.

ELECTRIC HOISTS. C. W. Hunt Company, New York.—Pamphlet No. 0115, in which are described the various forms of electric hoist built by this company. These range in size and duty from small deck and quarry hoists using 1-in. rope up to electric coal hoists for double-whip work using 1¼-in. rope.

DIRECT-DRIVEN REVOLVING-FIELD ALTERNATORS. General Electric Company.—Bulletin No. 4269 superseding Bulletin No. 4155, and describing the type of machine in which the field magnets are bolted to the rim of a large wheel mounted directly on an extension of the engine shaft, the armature being, of course, of the stationary housed type.

THE STERLING INCANDESCENT LAMP. The Sterling Electric Manufacturing Company, Warren, Ohio.—A pocket-size pamphlet containing a reprint of the article on "Symmetrical Distribution from Incandescent Lamps," which appeared in the October, 1901, issue of this paper, and a reprint of a shorter similar article from the *Electrical World and Engineer.*

FIFTY MILLION DOLLARS SAVED. The Economy Electric Company, Warren, Ohio.—This is the latest addition to the unique advertising literature that the Economy Company has been putting out with relation to its refilled incandescent lamps. The pamphlet contains some reasonable arguments in favor of the Economy Company's policy of replacing filaments in old bulbs and bases.

INCANDESCENT LAMPS FOR ISOLATED PLANTS. General Electric Company.—This is the General Electric Company's publication No. 1036, devoted to the selection and use of incandescent lamps for isolated plant service. Like all of the publications of this company, the book is handsomely executed, being printed on heavy plate paper and illustrated with high-grade half-tone engravings.

HAVE YOU A SYSTEM? The Holtzer-Cabot Electric Company, Boston, Mass.—A pocket-size catalogue handsomely executed and devoted to the merits of the intercommunicating telephone systems manufactured by the Holtzer-Cabot Company. The efficiency of these instruments is significantly indicated by the large list of users presented in the catalogue. These are located in practically every State of the Union and in several foreign countries also.

THE PELTON WATER WHEEL. The Pelton Water Wheel Company, San Francisco and New York.—The eighth edition of the Pelton catalogue, containing an illustrated description of the wheel, a table of data relating to the various sizes of impulse wheel, and considerable general information on the subject of hydraulic power. The catalogue also contains some interesting illustrations of equipments, and a telegraphic code which should be extremely useful to the company's customers.

EVIDENCE. The Shelby Electric Company, Shelby, Ohio.—An illustrated pamphlet pointing out the advantages incidental to the distribution of light afforded by the Shelby lamp, which delivers from two-thirds to 85 per cent. of the rated candle-power through the tip while delivering the rated illumination horizontally. The pamphlet also contains some strong letters of commendation from well-known authorities and records of comparative tests made with Shelby and other lamps by these authorities.

CLING SURFACE AT THE PAN-AMERICAN EXPOSITION. Cling-Surface Manufacturing Company, Buffalo, N. Y.—A folder on which is printed some interesting information as to the uses to which Cling Surface was put at the recent Buffalo Exposition. The services performed by this well-known preparation were widely varied, ranging from an application to a silk thread driving a cart wheel mounted on ball bearings up to the treatment of the huge belts which drove the cars of the Scenic Railway.

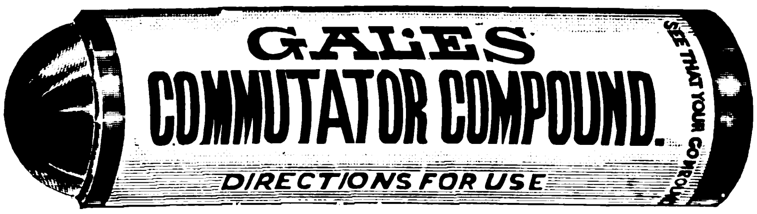
ELECTRICAL GLASSWARE. The Century Glass Co., Belaire, Ohio.—Pocket catalogues Nos. 3 and 5, the former devoted to incandescent lamp shades, which are made of opal glass in all the standard shapes. The latter contains outline illustrations with dimensions of inner globes and shades for enclosed arc lamps. These are made in all of the shapes used by the standard manufacturers of enclosed arc lamps, and are furnished in clear flint glass or opalescent and alabaster. Both catalogues are well executed, and the contents are arranged very conveniently for purchasers of such glassware.

BRIGHTON GAS ENGINES. Pierce-Crouch Engine Company, New Brighton, Pa.—An illustrated catalogue of standard size opening endwise, in which is described in detail the Brighton Company's engine. The standard Brighton engine is of the horizontal four-cycle type, built in sizes ranging from 5 to 75 horse-power. A smaller engine of the vertical type, known as the Brighton Junior, is also built in sizes of 1, 2 and 3½ horse-power. Engines of 6 horse-power and smaller are regulated by the "hit-and-miss" method; engines larger than 6 horse-power are provided with either throttling governors or the "hit-and-miss" type of governor, as preferred by the purchaser.

ALL THINGS ELECTRICAL. Electrical Material Company, Baltimore, Md.—This is a general catalogue of standard size and excellent make-up, devoted to electric lighting supplies and appliances; line materials and construction tools; fixtures, fixture parts and accessories; electrical glassware, arc lamp hangers and supplies; wires and cables; telephone instruments and appliances; electric heating appliances; electric bells, push buttons, annunciators, etc.; gas lighting apparatus; telegraph instruments; fire alarm instruments and apparatus; primary and secondary batteries and parts; small electrical specialties, such as alarm clocks, medical apparatus, battery fan motors, cigar lighters, etc.; standard types of ceiling and desk fan motors; Westinghouse dynamos, motors, transformers and meters ; electric railway material, and vitrified conduit.

HOPPES FEED WATER PURIFIERS AND HEATERS. The Hoppes Manufacturing Company, Springfield, Ohio.—An illustrated catalogue in which are described the well-known Hoppes feed-water heaters and purifiers, steam separators and oil eliminators and exhaust heads. One of the latest editions to the Hoppes line of apparatus is a combined steam separator and oil eliminator, which is built for insertion in either vertical or horizontal pipe lines. The book also contains photographic illustrations of pans taken from Hoppes purifiers after relatively short runs and showing an incrustation of lime which should be an effective object lesson. Directions for setting, connecting, operating and cleaning the purifier are also given.

A COMMUTATOR NECESSITY.



For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name.......... ....
Address..........
A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO.

BUSINESS NEWS.

GORDON BATTERY COMPANY, New York, manufacturer of the well-known Gordon primary battery cell, has removed from 13 Laight Street to very commodious quarters at 439 to 445 East 144th Street. The company's general offices will be at the factory.

HOT WATER PACKING.—After exhaustive tests covering a period of two years, the H. W. Johns Manufacturing Company, has placed on the market a packing to be used on plungers and rods of pumps delivering water at a temperature above 180 degrees Fahr.

E. C. MULCEY, electrical contractor, has opened an office at Oak Lane, above Eighth Street, Philadelphia, Pa. Mr. Mulcey will make a specialty of furnishing annunciators, burglar alarms, call-bells, electric lighters, electric fans, etc. He will also do all kinds of electric wiring and repairing. Mr. Mulcey has the best wishes of the electric fraternity for his new enterprise.

WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., has put out a new type of combined switch and enclosed-fuse holder which should be interesting to contractors and construction men in general. By carrying a small stock of these appliances, panel-boards can be built on short notice for any number of circuits and any combination of terminals.

BROWN & FROTHINGHAM, of New York City, export sales agents for several prominent manufacturers, announce that they have opened a department for the export of machine tools, which has been placed in charge of Mr. A. M. Fisher. Mr. Fisher has just returned to New York after devoting three years in Japan to the foreign machine tool business.

THE RENIM SPECIALTY COMPANY, Boston, Mass., has removed to the new Weld Building, 176 Federal Street, where an entire floor has been handsomely fitted up for its occupancy. The company's offices, show rooms, stockroom and packing room will all be located at this address, giving unusually favorable facilities for sales to visiting customers and for the prompt execution of orders thus received.

H. W. JOHNS MFG. COMPANY, New York, and the MANVILLE COVERING COMPANY, of Milwaukee, Wis., each of which companies has been closely identified by handling each other's goods, have been consolidated under the style of the H. W. Johns-Manville Company. The capital stock of the new company is $3,000,000, and the officers are T. F. Manville, president; Geo. W. Gladwin and C. B. Manville, vice-presidents; F. R. Boocock, treasurer, and H. E. Manville, secretary. C. R. Manville will be manager of the western department, with headquarters at Milwaukee. The new company is rapidly completing a plant at Milwaukee for the manufacture of carbonate of magnesia and mineral wool. When this is finished the company will be in position to furnish a most complete line of pipe and boiler coverings and asbestos goods of all descriptions and grades.

AMERICAN DISTRICT STEAM COM
Lockport, N. Y., recently installed at Atlant
one of the largest exhaust-steam-heating
that has ever been built. One of the principal
siderations on the part of the electric light co
pany in putting in this plant was the advantage that it gave the company in dealing with large office buildings and small establishments which had their own engines, boilers and lighting equipment. By being able to supply heat in addition to power and lighting, the company secured many contracts which it would otherwise not have obtained.

THE MONTAUK FIRE DETECTING WIRE COMPANY, New York, is justly gratified by the following official report of the committee on exhibits at the Pennsylvania State Firemen's Convention, recently held at Philadelphia:

"The Montauk fire-detecting wire is a wire which is affected by dangerous heat or by the smallest flame (even a match) and gives an alarm in from ten to fifteen seconds. It is a continuous thermostat or like a watchman always on guard in every nook and corner. It is so simple any one can understand it; it has the approval of the Fire Underwriters of the City of New York, and is being rapidly introduced. Some of its recent installations protect millions of dollars' worth of property.

"It is efficient as a burglar alarm and is of such a nature that it can be spliced to other wires where there is danger of fire. It can be used for door bell service, call bells and electric work of various kinds and yet keep a watch for fires, and what is more, tell of a fire quicker than any other known appliance.

"A local electrician can install it, as there is nothing complicated. It is simply a double-conductor wire and is finished in any covered or colored insulation desired. The senior counsel of the Bell Telephone Company says, 'It constitutes a monopoly as a fire detecting wire.'

"This exhibit deserves your careful consideration. The wire does not reduce the fire hazard, but it does absolutely give a warning quicker than any other known agency and is a valuable adjunct to protection of life and property. It deserves our hearty endorsement.

(Signed) F. B. BOSCH, Secretary.

JAMES G. BIDDLE, Philadelphia, has received orders recently for cable-testing equipments from such prominent companies as the Bell Telephone Company of Philadelphia; Keystone Telephone Company, Philadelphia; Inter-State Telephone Company, Trenton, N. J.; Reserve Construction Company, Cleveland, Ohio, and the Pittsburgh & Allegheny Telephone Company, Pittsburgh, Pa. All of these outfits included one or more of the Fisher cable testing sets, made by Morris Leeds & Company, for whom Mr. Biddle is sole selling agent.

Telephone
The
Time-Saver.

In Manhattan:
Business Service
from $5 a month.
Residence Service
from $4 a month.

New York Telephone Co.
15 Dey St. 111 West 38th St.
215 West 125th St.

CREAM FLUX

An Absolutely Non-Corrosive Insulating Soldering Flux FOR ALL METALS.

So EASILY APPLIED that all CAN USE IT.
So CHEAP that all SHOULD USE IT.
So EFFICIENT that all MUST USE IT.

PUT UP IN CANS AT
15c., 25c., 45c. and 75c.
SPECIAL PRICES IN QUANTITY.
SEND FOR TRIAL BOX.

Endorsed by the National Board of Fire Underwriters and all users.
We guarantee it, and if not satisfactory, money will be refunded.
FOR SALE BY ALL SUPPLY HOUSES OR

CREAM FLUX CO., SOLE MANUFACTURERS, 100 Washington St., **CHICAGO**

HARE'S
COMMUTATOR
COMPOUND

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.

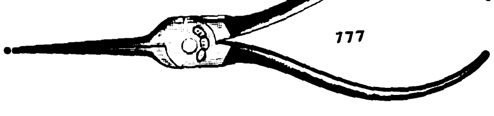
ERICSSON

Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.

CATALOGUE FREE ON APPLICATION.

Ericsson Telephone Co., 296 Broadway. N. Y. City.

WE have not enough room here to tell you about this handy tool for linemen and electricians, but if you wish it we will send you a GREEN BOOK of Hardware Specialties which does.



UTICA DROP FORGE TOOL CO.,
SMITH & HEMENWAY CO.,
296 Broadway, New York City.
Ask your dealer for these goods.

An INCANDESCENT LAMP represents a large investment of cap'tal, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

BAKER & CO.'S PLATINUM

408 N. J. R. R. Ave., NEWARK, N. J. 120 LIBERTY ST., NEW YORK
We buy and Refine Platinum Scrap also

JAS. BEGGS & CO., New York, general agents for the Potter mesh separator and superheater, state that all of the boilers of the Edison Electric Illuminating Company, Paterson, N. J., have been equipped with this appliance. The electric light company, it is stated, reports that the quality of steam at the boiler outlets has been improved 50 per cent., as shown by calorimeter tests.

EUREKA ELECTRIC COLOR COMPANY, New York, has succeeded to the business of the Lavarite Manufacturing Company, and will continue the business of manufacturing coloring and frosting preparations for incandescent lamps. The company's headquarters are at 21 and 23 Ann Street

THE AMERICAN ELECTRICAL & MAINTENANCE COMPANY, New York, has been authorized by the Supreme Court of the State of New York to change its name to "James Reilly's Sons Company." This change has, therefore, been made, and went into effect on Jan. 1. There will be no change in the management or business policy of the concern.

THE BURT MANUFACTURING COMPANY, of Akron, Ohio, recently received an order from the De Beers Consolidated Mining Company, Limited, of Kimberley, South Africa, for a very large Cross oil filter, to be used in the mining company's new power house. Only American machinery will be used in this plant and the Burt Company considers this order a strong endorsement of the Cross filter.

A. W. FRANCE, Philadelphia, Pa., reports among other recent orders for his well known metallic packing the following: Metropolitan Street Railway Company, New York, 31 sets; New York Gas & Electric Company, 48 sets; Kings County Electric Company, Brooklyn, 22 sets; Brooklyn Heights Railroad Company, 14 sets; Fitchburg Steam Engine Company, 6 sets; Bass Foundry & Machine Company, 8 sets; Grand Central Railroad Station, New York, 20 sets; Nordberg Manufacturing Company, 24 sets; The Hooven, Owens & Rentschler Company, 6 sets.

THE CUTTER COMPANY, Philadelphia and New York, on Jan. 1 assumed the sole management of the sales of the well-known instruments manufactured by the Keystone Electrical Instrument Company, of Philadelphia. These instruments will be made as heretofore by the Keystone Company under the direct supervision of Mr. J. Franklin Stevens. A number of important changes and improvements have been made recently in the Keystone instruments, and these improvements, coupled with the able management of the Cutter Company, should result in a large increase in sales.

THE WHITLOCK COIL PIPE COMPANY, Hartford, Conn., reports an unusually large volume of business. This company has nearly trebled its output within the last two years, and is now at work on plans for the erection of additional shops to meet the increasing demand. The present shops are running overtime, and will begin to run day and night with two shifts immediately after the first of the year. The company recently completed a single order for 10,000 horse-power of the American Standard copper-coil feed-water heaters, and has just shipped a "repeat" order of 4,500 horse-power to the Cambridge Electric Light Company for its new plant at Cambridgeport, Mass.

JAS. McCREA & COMPANY, Chicago, manufacturers of the Roberts boring machine, report an excellent demand for this machine. The firm has spared no expense in the way of material and workmanship, and no pains in its effort to turn out a machine that will meet with absolute satisfaction the demands of the severe service to which such an appliance is put, and it is very gratifying to have these efforts appreciated as in the case of one company that has increased its equipment of Roberts machines steadily until there are now eight in constant use.

O. K. SPECIALTY MANUFACTURING COMPANY, Garrettsville, Ohio, calls attention to a combination switch and cut-out which, it is said, embodies entirely new features. In the construction of this device the company uses the patent spring compression jaws which are used on all of its switches; the object of this arrangement is to prevent the switch from being jarred open when mounted in an inverted position. These appliances are guaranteed to carry double their rated current without danger of destruction.

CROCKER-WHEELER COMPANY, of Ampere, N. J., is being pushed to its utmost to keep up with its orders. The company has several times added to the number of its employees lately, but it has been necessary for some months to work night and day in order to make shipments with a satisfactory degree of promptness. The year which has just come to a close has been an extremely prosperous one for the company; the mid-winter business has broken all previous records. Among recent notable sales were the following: A complete motor equipment for the United States Tube Company, Buffalo, N. Y.; a complete equipment for the C. P. Curran printing establishment, St. Louis, Mo.; a 30-kw. special generator for the Sultan of Linga, to be installed in the royal palace on an island near Singapore; a 45-kw. direct-connected generator, with an equipment of between 50 and 60 motors, for the Government Printing Office in Manila; 13 motor-dynamos for the Western Union telegraph office, Milwaukee, Wis., and a complete electrical equipment, comprising a generator and 28 motors, for the Skinner & Sethman Publishing Company, Denver, Col.

THE HAINES & NOYES COMPANY, Chicago, maker of telephone apparatus, announces the appointment of the following agencies: Gilson & Hatch, Lynn, Mass.; Geo. R. Mathieu and C. K. Hill, Pittsburgh, Pa.; Roak & Rittenhouse, Philadelphia, Pa.; Federal Electric Company, export agents, New York; Risley & Boniface, Atlantic City, N. J.; J. E. Henry & Company, Baltimore, Md.; H. I. Sackett, Buffalo, N. Y.; J. A. Erner & Company, Cleveland, Ohio; Porter Bros., Louisville, Ky.; Jas. Clark, Jr., & Company, Louisville, Ky.; W. T. Osborn & Company, Kansas City, Mo.; Overton Manufacturing & Engineering Company, Topeka, Kan.; Portland General Electric Company, Portland, Ore.; Woodill & Hulse Electric Company, Los Angeles, Calif.; The John M. Klein's Electrical Works, San Francisco, Calif.; Chas. W. Geib, Spokane, Wash.; T. W. Tugglem, Beaumont, Texas; T. W. Rachford, Springfield, Ill., and Brickson Electrical Equipment Company, Boston, Mass. E. H. Van Duzee, Jr., & Company, St. Paul, Minn., have been made agents for all exchange business in the northwestern States.

THE WARREN COMPANY, Chicago, Ill., manufacturer of the well-known Warren pulley cover, is receiving a continuous stream of commendatory letters concerning its pulley cover. Among a large batch of letters recently received were the following:

"Since writing my last letter we have had our 33-kw. alternator pretty well loaded, and we keep the belt running loose with no trouble from slipping; whereas before that, the attendant had to tighten the belt every evening and apply something sticky in order to pull one-third of the rated load. A. R. Sawyer."

Lexington, Ky.

"Answering your favor of October 3, I would say that the pulley covering which we bought of you was applied to some of our largest belts and has given perfect satisfaction. It seems as though it would never wear off, and it certainly prevents slipping and will allow a belt to pull all that the leather can stand.

Chattanooga (Tenn.) Light & Power Co.
B. T. Burt, Superintendent."

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THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIV. New York, February, 1902. No. 2.

SINGLE PHASE TRANSMISSION PLANT WITH POWER DISTRIBUTION.

THE WATER-POWER PLANT AT LA GOULE.

In the light of the prevailing American practice in alternating-current transmission work, the equipment of a transmission plant with single-phase apparatus seems extremely odd. Nevertheless there are in Europe several plants of very respectable size and covering considerable distances in which single-phase apparatus is exclusively employed. One of the most notable of these is the station and system of the Société des Forces Électriques de la Goule. The power house is located at La Goule on the river Doubs, which forms the boundary line between France and Switzerland at this point, and current is supplied to various villages and towns along the river on both sides of it, transformer stations being situated at eleven of the towns and distributing lines radiating from these to villages in the immediate vicinity of each. The longest transmission line extends to the town of Renan, a distance of 12 miles from the power house as the line runs. The next longest line terminates at two sub-stations located in Tramelan, nine miles from the power house, measured along the pole line.

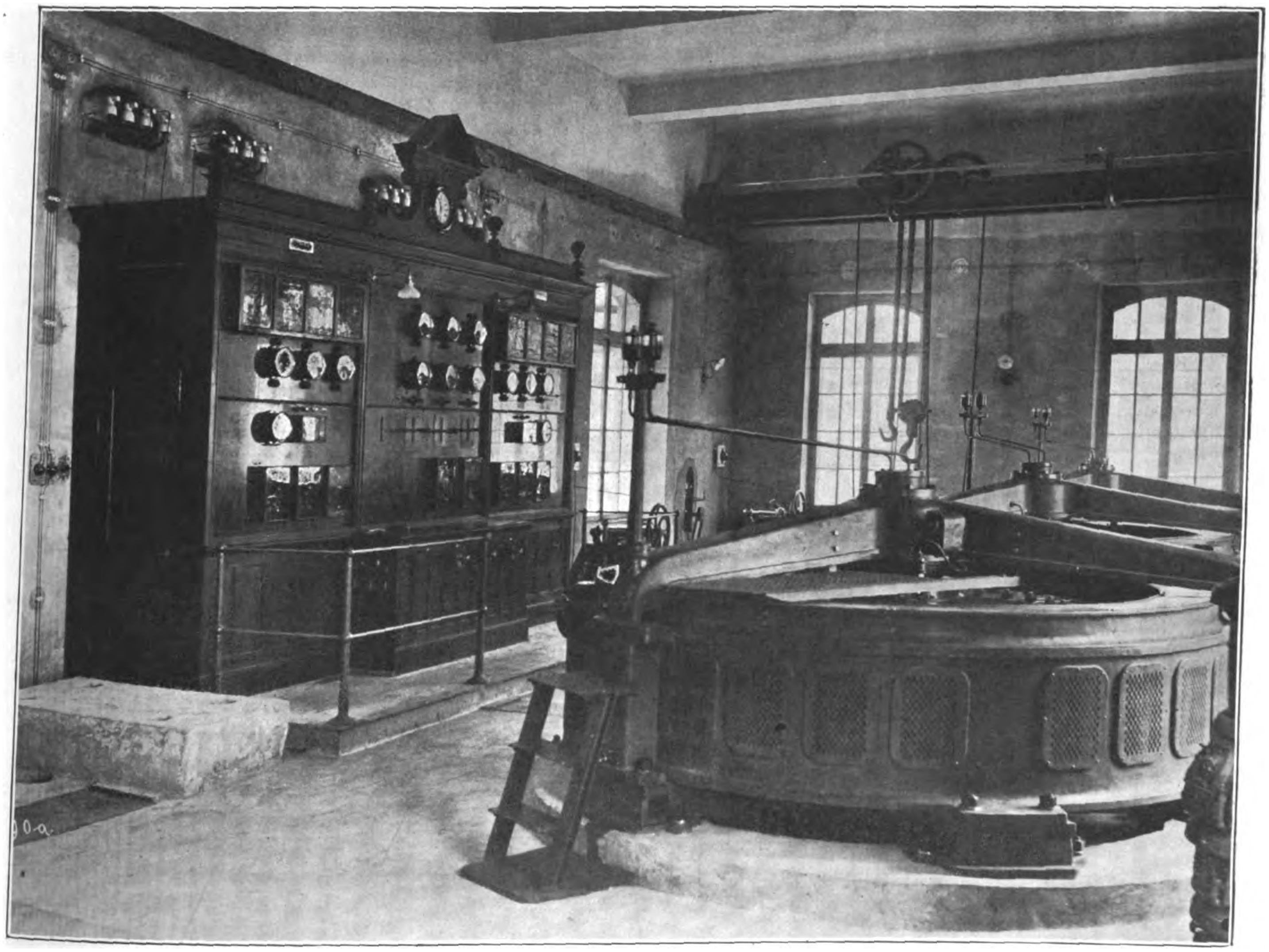

FIG. 1.—CORNER OF GENERATING ROOM AT LA GOULE.

The motive power is hydraulic, water being taken from the river Doubs through a tunnel 1444 ft. long and a canal 263 ft. long. The effective hydraulic head is 85 ft. 3 ins., and the velocity of the water in the flume formed by the canal and tunnel is a trifle over 6½ ft. per second, or about 400 ft. a minute. The capacity of the flume is approximately 4000 horse-power, but the power-house was designed and built for an ultimate output of about 8000 horse-power. At the power-house the flume discharges into wrought-iron tubes 7 ft. 4½ ins. in diameter, made up in lengths 20 ft. long.

The power house contains four generating units, each comprising a turbine and a horizontal single-phase alternator with its revolving member mounted on the upper end of the turbine, as indicated by Fig. 4, which is a cross-section of the power-house. Three of these generating units are of 500 h.p. capacity, and the fourth one is of 650-h.p. capacity. The three 500-h.p. units were put in first, and a single framework was built for the three, as indicated in Fig. 1, which shows these three units and the switchboard. All four of the turbines were built by Escher, Wyss & Co., of Zurich, Switzerland, and are what is known as the Francis type. The 500-h.p. machines run at 200 r.p.m. and are said to have shown an efficiency of 80 per cent at three-quarter load and 79 per cent at full load under an exhaustive test. The 650-h.p. turbine runs at 375 r.p.m. and developed an efficiency of 81 per cent at three-quarter load and 79 per cent at full load under test. Automatic speed regulators of the well-known type built by Escher, Wyss & Co. are used in connection with the turbines.

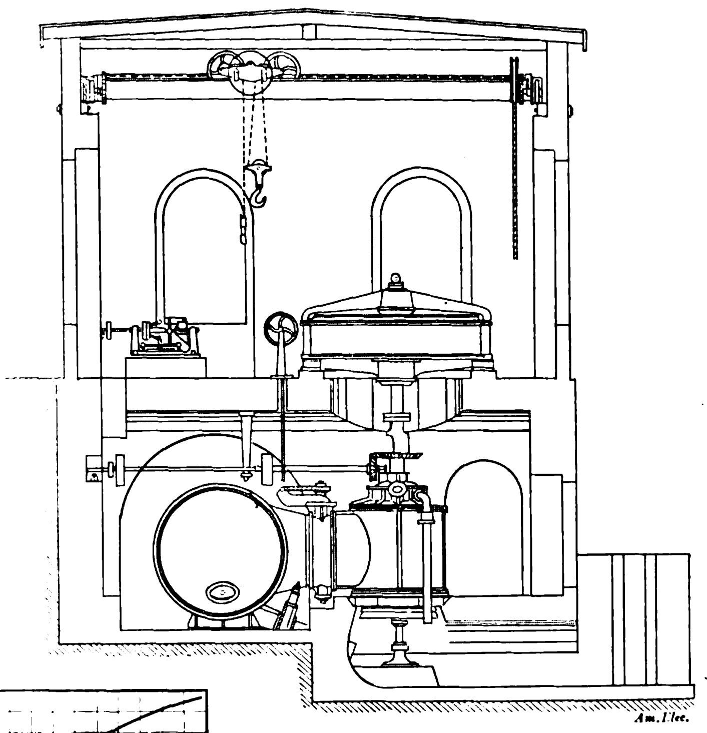

FIG. 5—.CROSS-SECTION.

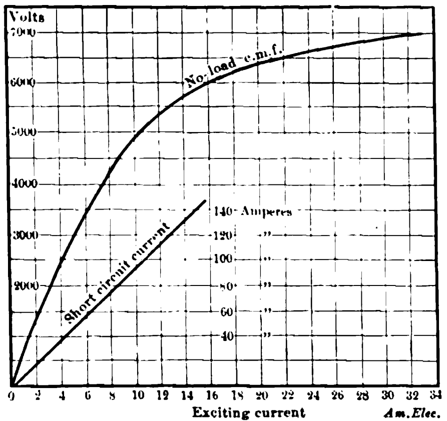

FIG. 2.—350-KW. CHARACTERISTICS.

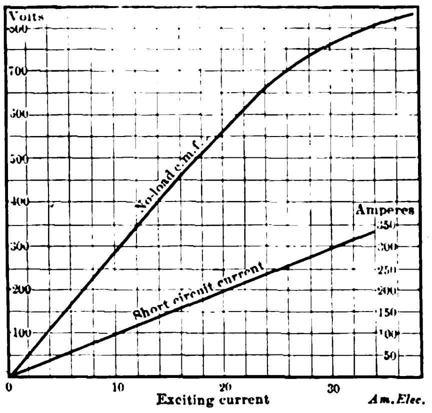

FIG. 3.—500-KW. CHARACTERISTICS.

As previously stated, the alternators are all single-phase machines, and were built at the Oerlikon Works. All of them are of the revolving-field type, but the field magnets of the three smaller machines are of the single-coil form, with the field poles projecting axially alternately from one side of the base rim across the coil to the other side; this being the type originated by Mr. C. E. L. Brown at the time of the celebrated Frankfort-Lauffen experiment eleven years ago. Fig. 7 is a vertical cross-section and a semi-sectional plan of one of these machines, from which the construction mentioned may be easily understood. The last alternator to be installed, which is the largest one of the group, is of the ordinary radial-pole type, arranged horizontally on the upper end of the turbine shaft like the smaller machines, but with the magnet poles individually wound. This construction is indicated in Fig. 8. The three smaller machines have a capacity of 64 amperes and 5500 volts, and supply current at a frequency of 50 cycles, there being 30 polar projections. There are correspondingly 30 armature coils, each consisting of 20 turns of wire having a rectangular cross-section of 0.16 x 0.185 in. The single field magnet coil has 500 turns of wire, the cross-section of which is 0.216 x 0.244 in. The diameter of the air-gap is 98 ins. Each of these 350-kw. alternators requires 2400 watts for excitation.

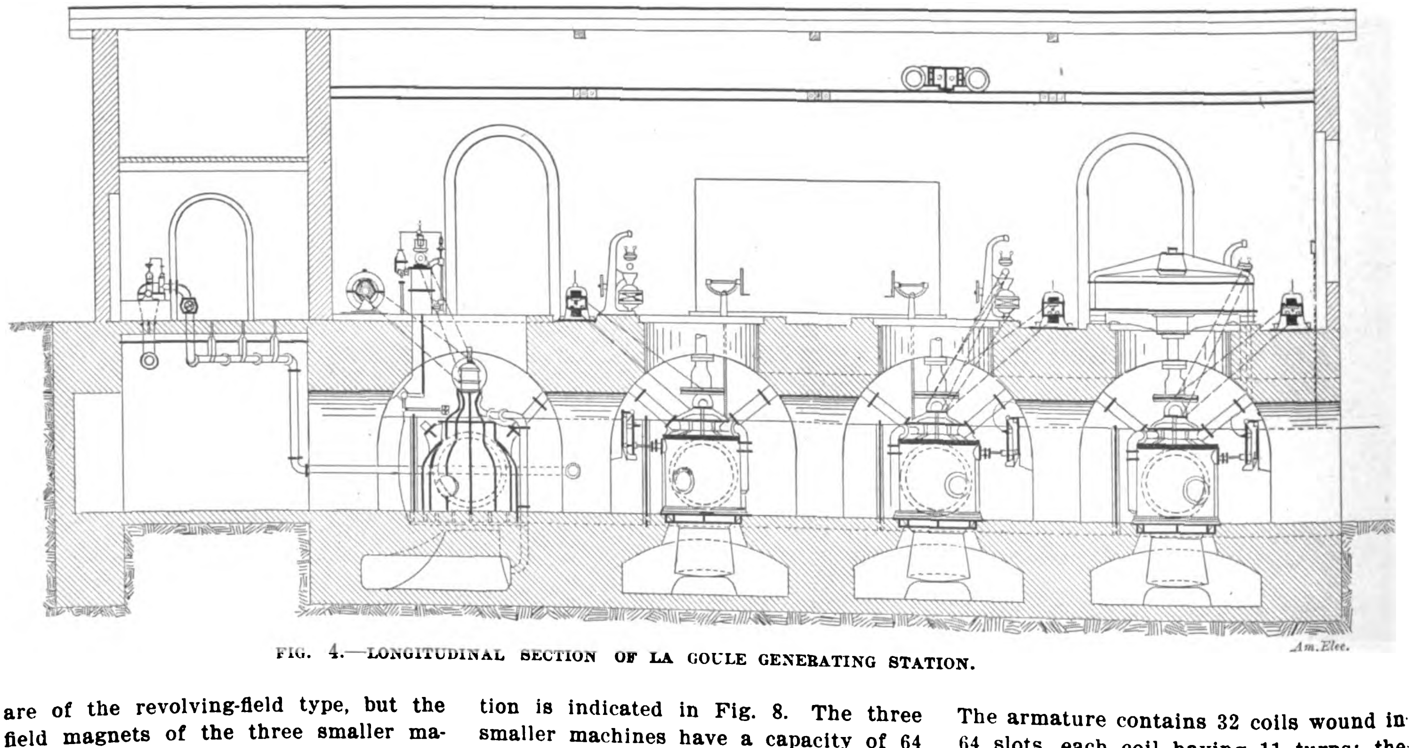

FIG. 4.—LONGITUDINAL SECTION OF LA GOULE GENERATING STATION.

The fourth alternator is a 550-kw. machine, having a capacity of 100 amperes and 5500 volts. Its frequency is, of course, 50 cycles, like that of the smaller machines. There are 16 magnet poles, each wound with 18 turns of copper ribbon 0.059 in. thick and 7.09 ins. wide, insulated by asbestos ribbon 0.02 in. thick. The armature contains 32 coils wound in 64 slots, each coil having 11 turns; the conductor consists of three wires in parallel, each 0.15 x 0.173 in. The air-gap diameter of this machine is 70 ins. Figs. 2 and 3 show the characteristic curves of the two sizes of alternator, together with the short-circuit current line. The scale figures on the left of the diagram in each case are the no-load terminal voltages applying to the characteristic curve, and the scale of amperes within the body of the diagram gives the short-circuit current values applying to the straight line. The full-load efficiency of the 350-kw. machines is 94 per cent, and that of the 550-kw. machine is 94.8 per cent.

The exciting current for each alternator is supplied by a 2½-kw. dynamo, which is driven from the shaft of the main generating set through the medium of gears, a countershaft and belting. Fig. 5 shows the gearing and countershaft, but does not show the exciter dynamo. Another 2½-kw. bipolar dynamo, the construction of which is clearly shown by Figs. 9 and 10, is used for lighting the station and supplying power to motors driving machine tools in the repair shop. This machine is driven at 1300 r.p.m. by a 5.6-h.p. turbine, which runs at 620 r.p.m., the dy-

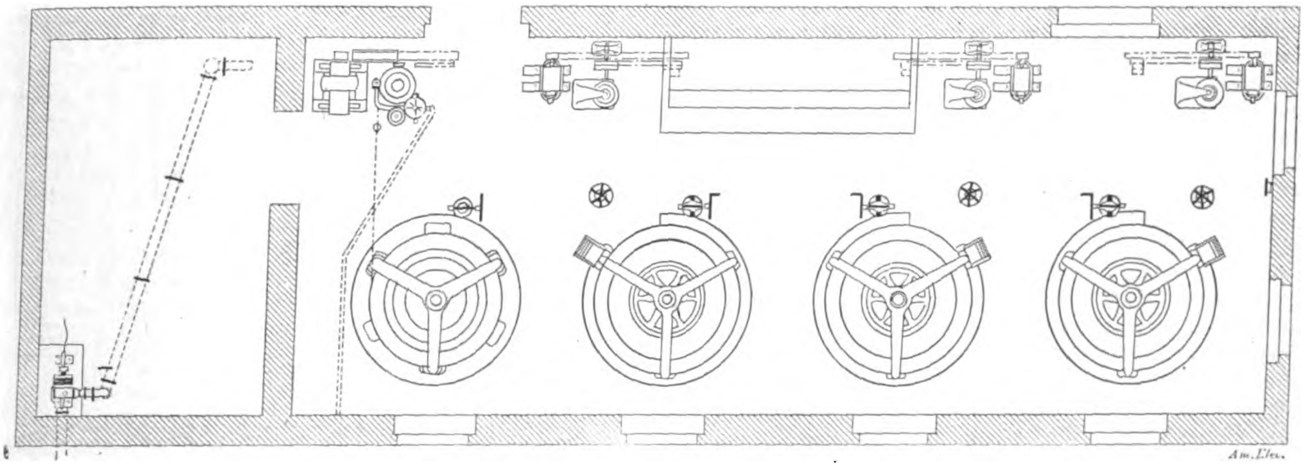

FIG. 6.—PLAN OF LA GOULE GENERATING STATION.

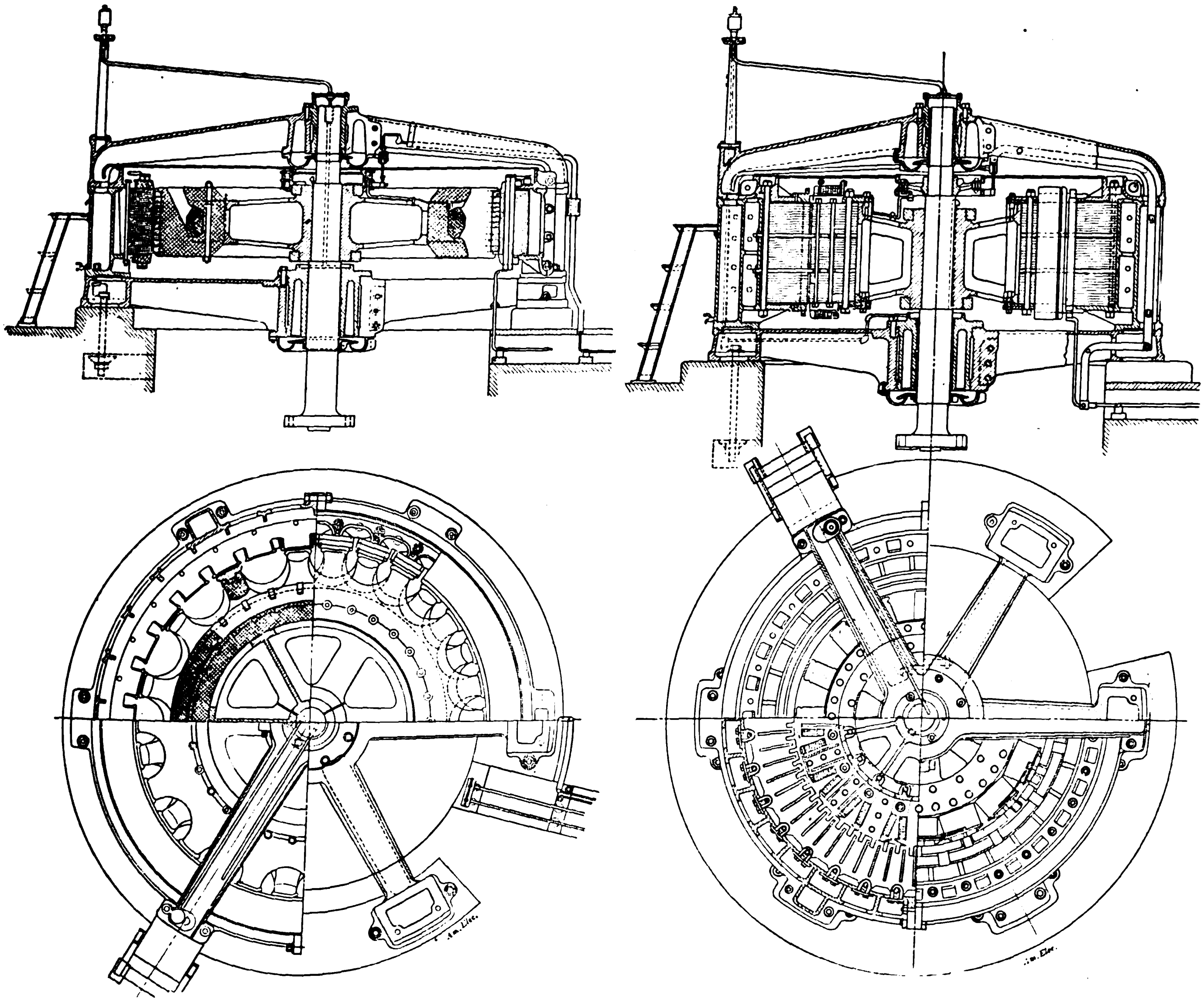

FIG. 7.—VERTICAL CROSS-SECTIONAL AND SEMI-SECTIONAL PLAN VIEWS OF GENERATORS.—FIG. 8.

namo being belt-driven. A feature of this little machine which will appear odd to American engineers is that its field-magnet cores and yoke are of cast iron, and the pole shoes of wrought iron, the prevailing practice in this country being precisely the opposite so far as relative magnetic values are concerned. This dynamo is located in a small room adjoining the main generator room, which is used as a workshop and repair room.

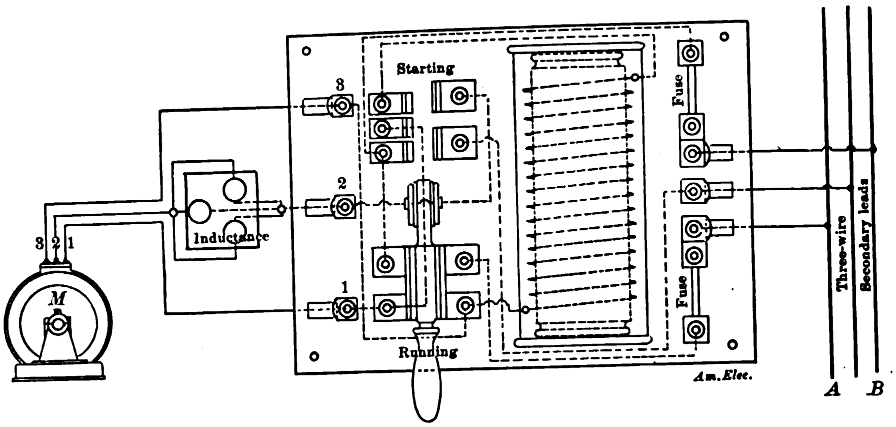
Starting
3
2
1
Inductance
M
3 2 1
Running
Fuse
Fuse
Three-wire
Secondary leads
A
B
Am.Elec.

FIG. 11.—DIAGRAM OF STARTING-BOX CONNECTIONS.

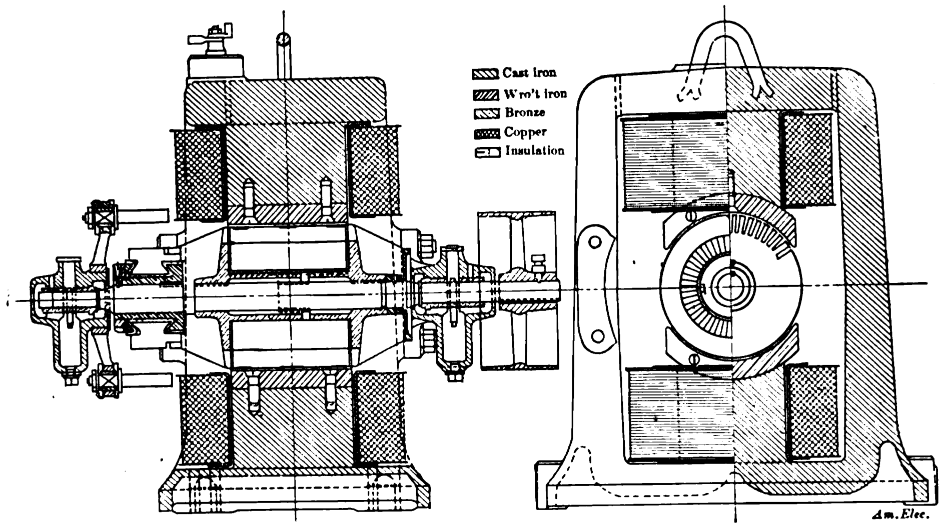
Cast iron
Wro't iron
Bronze
Copper
Insulation
Am.Elec.

FIG. 9.—BIPOLAR DIRECT-CURRENT DYNAMO.—FIG. 10.

Fig. 12 is a diagram of the switchboard connections, from which it will be evident that there are four generator panels and eight feeder panels, one-half of the feeder panels being for the lighting circuits and the other half for the power circuits. The reference letters in the diagram have the following significance: *A* indicates a generator or a feeder ammeter; *C* is a double-throw switch for connecting the corresponding alternator to either the lighting or the power bus-bars; *E*, an exciter; *F*, a bank of fuses; *G*, an alternator; *J* is a relay; *Ph*, a phasing plug socket; *S*, a double-pole main generator switch; *S f*, a double-pole feeder switch; *T*, a potential transformer for the voltmeter; *T C*, a compensating transformer opposing the potential transformer with which it is connected, so as to compensate for the drop in the line, and *V* indicates a voltmeter. The picture from which Fig. 1 was made was taken before the switchboard was completed, so that all of the equipment indicated in the diagram is not shown there.

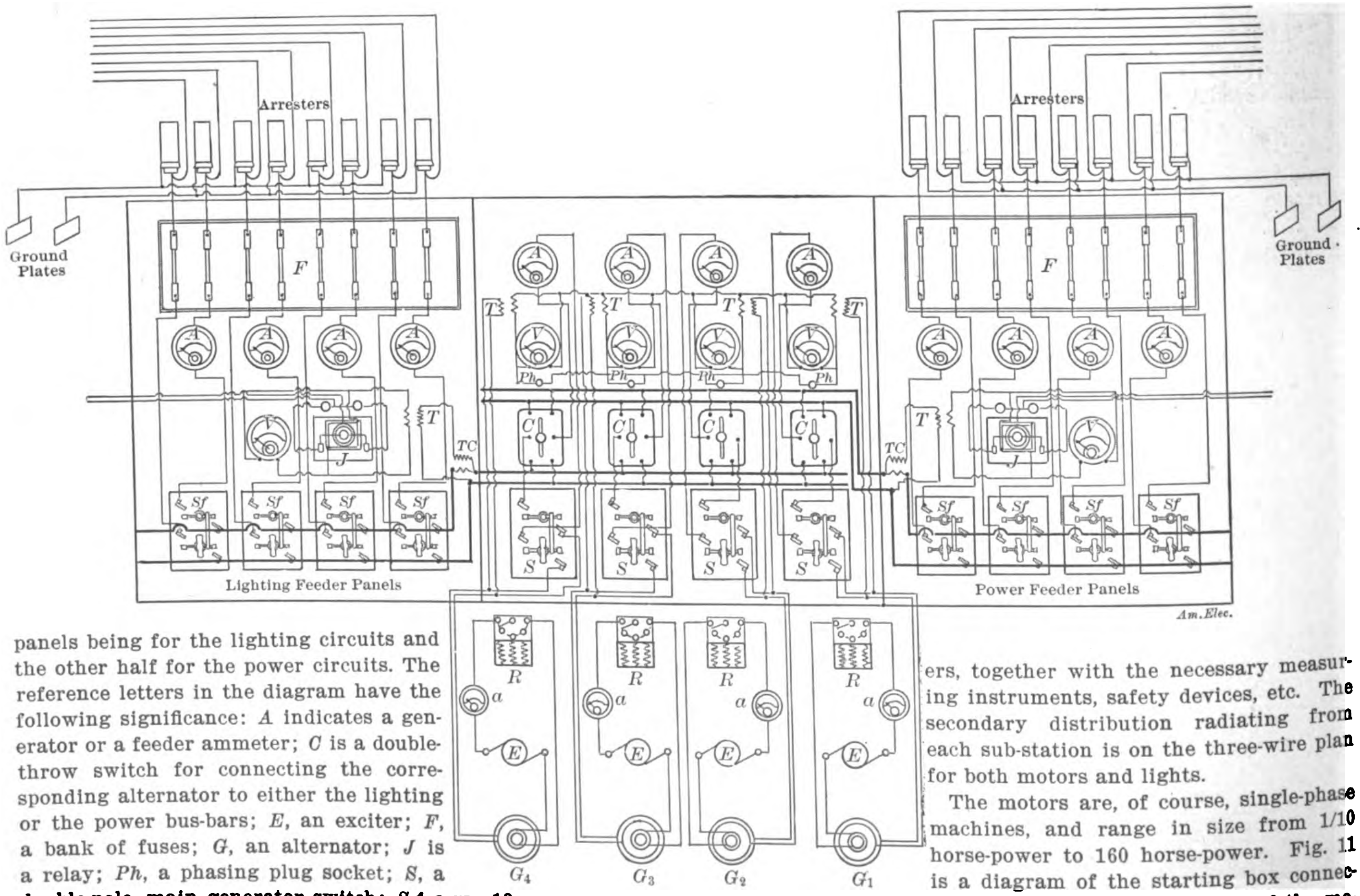
Arresters
Arresters
Ground Plates
Ground Plates
F
F
A
T
V
Ph
C
J
TC
Sf
S
Lighting Feeder Panels
Power Feeder Panels
R
a
E
G₄
G₃
G₂
G₁
Am.Elec.

FIG. 12.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

The transmission lines upon leaving the station go up over a high bluff and are carried on tripod supports, as indicated in Fig. 13, instead of the ordinary single pole. There are three lighting circuits and three power circuits to various points in Switzerland, and two lighting and two power circuits to towns located on the French side of the river. Each sub-station contains the usual step-down transformers, together with the necessary measuring instruments, safety devices, etc. The secondary distribution radiating from each sub-station is on the three-wire plan for both motors and lights.

The motors are, of course, single-phase machines, and range in size from 1/10 horse-power to 160 horse-power. Fig. 11 is a diagram of the starting box connections for a motor. The stator of the motor is wound with a divided primary, the terminals being numbered 1, 2 and 3. Tracing the connections, it will be found that with the switch handle in the upper position, marked "Starting," the motor is connected between the neutral wire and the outer wire, *B*, of the supply circuit, thus giving the primary winding only one-half of the total voltage of the circuit. One of the familiar phase-splitting arrangements is employed to produce a rotating magnetic field for starting. When the machine is up to speed, the switch is thrown to the position shown in the diagram, thus connecting the outer terminals of the motor to the outer wires, *A* and *B*, of the supply circuit, and leaving the middle wires disconnected.

It may be interesting to American central station managers to note the rates charged by this company for lighting and power service. For private lighting, the rate is 1.4 francs (about 28 cents) per candle per year, making the rate for a 16-c.p. lamp about $4.50 per year. For watch factories, many of which in both Swiss and French territory use both the lighting and power service, the rate is 10 francs ($2) a year for each 10-c.p. lamp, and the motor rates are 134 francs (about $26) for a ¼-h.p. motor; 346 francs (about $79) for a ¾-h.p. motor, and 430 francs (about $86) for a 1-h.p. motor per year. For motors developing from 2 horse-power to 12 horse-power, the rate is 325 francs ($65) per horse-power per year, and for larger machines still lower rates are made. The plant is operated continuously day and night, except half an hour each day between 12:30 and 1 p. m.

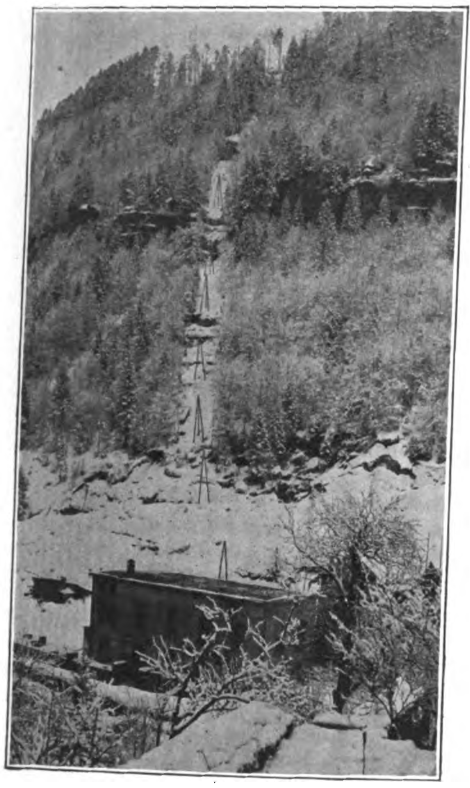

FIG. 13.—TRANSMISSION LINES OUTSIDE THE POWER-HOUSE.

TRANSVERSE STRESSES IN STEAM PIPES.

BY A. S. MANN.

LIMITING EFFECT OF SCREWED JOINTS.

The important feature of a joint in a steam pipe is its ability to be made tight and stay tight, and if a man has a new joint to sell his first claim would be that it could not be made to leak when in common use. But a feature quite as important is to have a joint that is as strong as the body of the pipe, particularly in a transverse direction. There are several methods of making joints that preserve the full strength of the metal in pipe having a diameter of 6 ins. or more. A pipe having a full thread cut into its body and having the flange or fitting into which it is screwed tapped out small so that there will be some of the thread on the pipe left bare, cannot, of course, be as strong as the full uncut pipe; and these threads are at the very worst place, where the bending moment is greatest.

In making a threaded joint without peining, it is almost impossible to make up the thread tight when the fitting is tapped out large enough so that all the thread on the pipe is covered. It is, in fact, common practice for the man running the pipe machine to so adjust his dies that the thread will make up tight and solid and still have two threads or more left bare. And any man who has attempted to make an unusually fine appearance with screwed work, and so cut his threads that they cover themselves up, is pretty sure to declare vehemently that it is the last job he will ever try it on before he is through. It is possible to make almost any threaded joint tight, even if the thread is somewhat loose, by peining the pipe; and if this method is employed it is possible to cover up the threads pretty well. But unless the thread is all covered, and the bore of the fitting extends well over the thread, the pipe must be weak at the thread.

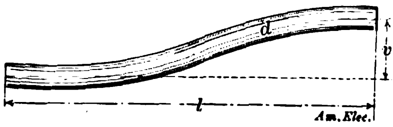

FIG. 1.

When a pipe is threaded at each end and flanges are screwed on, and the pipe used as a branch connecting a fixed nozzle to a steam main, the expansion of the main will make the branch bend first in a reverse curve, as shown in Fig. 1, and second, around two curves of sharper radius, as shown in Fig. 2, and the pipe takes a form that may be called the resultant of these two shapes. The figures are shown separately, so that the lettering will be more distinct. The deflection, *v*, in Fig. 1, is given by the equation:

$$v = \frac{1}{3\,E} \times \frac{X\,l_2}{d},$$

as was shown in a preceding article, and with the same notation, the significance of *d*, *l* and *v* being shown in Fig. 1. *E* is the modulus of elasticity and *X* the stress in the most strained fiber. *X* has a different numerical value here, however.

The bending moment at either end must not be greater than what can be safely carried by the bottom of the thread. So the first step will be to determine what this safe bending moment is, and from this bending moment calculate the corresponding fiber stress in the full and uncut pipe, which value, substituted for *X*, in the formula, will give the value of *v*, Fig. 1. There is a standard number of threads and a standard depth of thread for all sizes of pipe from ⅛ in. to 14 ins., and it is to be expected that at least one full thread will be subjected to the stress of the maximum bending moment. Pipes having diameters from 14 ins. to 2½ ins. have 8 threads per inch, and twice the depth of a standard thread is 0.163 in.; if this value is deducted from the standard outside diameter of the pipe, the diameter at the bottom of the thread evidently will be the remainder. Pipes having diameters from 2 ins. to 1 in. have 11½ threads per inch, and the double depth of thread is 0.113 in.; ¾-in. and ½-in. pipes have a double depth of thread of 0.0935.

The diminished thickness of metal must resist the internal pressure of the steam first, and dividing the total pressure (pressure × internal area) by the area of metal at the bottom of the thread gives the intensity of stress due to steam pressure. This is appreciably greater in the case of threaded pipe than in the case of solid pipe, as, for instance, with 150 lbs. pressure, 8-in. solid pipe has a longitudinal stress of 895 lbs., while the threaded section has a corresponding stress of 1217 lbs. per square inch, leaving 14,783 lbs. available for the bending stress.

Representing the maximum allowable bending moment at the bottom of the thread by M_t; the safe fiber stress, after deducting the stress due to steam pressure, by X_t the moment of inertia at the bottom of the thread by I_t, and the diameter at the bottom of the thread by d_t the equation becomes:

$$M_t = \frac{2\,X_t\,I_t}{d_t}.$$

Now, inasmuch as the length of the exposed thread is short, as compared with the length of the pipe, it may, without much error, be assumed that this bending moment does not diminish when transferred to the nearest full section. If it seems that in any given case this error is too great, the length of the threads exposed may be added to the computed length of the branch. But it is also to be remembered that when a pipe is nicked part way through by the thread, and the fracture is compelled to take place at that particular spot, and cannot choose the weakest spot in the immediate region, the modulus of rupture will usually be higher than in the case of the full uncut pipe.

Making the assumption proposed above,

the allowable fiber stress in the solid pipe becomes:

$$X = \frac{M_t\ d}{2\ I}$$

where the letters signify for solid pipe just what the same letters with subordinate letter *t* do with threaded pipe. Substituting for M_t its value as expressed above, the equation becomes:

$$X = X_t \frac{I_t}{I} \frac{d}{d_t}.$$

Here now is a value which may be substituted in the equation first given, making the value of $v = \frac{1}{3\ E} X_t \frac{I_t}{I} \frac{l^2}{d_t}$, all of which terms have numerical values and are known. This deflection will allow for the expansion of a certain length of main, which length may be found by dividing this value of v by .00125, so if L_1 represents the length in inches, the equation for L_1 becomes:

$$L_1 = \frac{1}{.00375\ E} X_t \frac{I_t}{I} \frac{l^2}{d_t}, \text{ or}$$

$$L_1 = .000009524\ Xt \frac{I_t}{I} \frac{l^2}{d_t},$$

and this length, L_1, represents the length of main pipe which will be cared for by the deflection of the branch shown in Fig. 1.

Fig. 2 is made up of two curved ends joined by a straight line. The threaded portion at an end, however short, deflects as a beam, but because of the small proportion of length of thread to whole length of pipe, this small deflection may be neglected. The angle through which the end curves is important, for if the tangent of this angle be multiplied by the length of the pipe, the result is a measurable deflection. For calculating this angle, the end of the pipe is to be considered a beam supported as a cantilever at one end, with a load at the other, the beam length being equal to the length of exposed thread. This thread length varies, of course. A fitting or flange is screwed on till the thread makes up, and whether there are three threads or six left over is never considered. The aim of the man cutting the pipe is, however, to have a certain chosen number of threads exposed when the joint is made up tight.

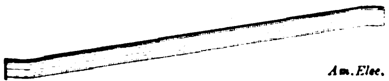

FIG. 2.

It is clear that some bending takes place inside the fitting or flange hub. This hub must spring some, and the very edge of a cast-iron hub, or the edge of the hub made of any other material, as steel, cannot furnish a sharp corner where the bending must begin. In these articles the length of this thread has been chosen as 0.5 in. for pipes from 14 ins. to 2½ ins. at each end, and the resulting formulæ are true for that length. The length of exposed thread chosen for pipe having 11½ threads per inch is 0.4 inch, and so decreasing till for ¼-in. pipe a length of 0.2 in. was chosen. These lengths will seem reasonable when the actual pipe, as erected, is considered. One-half an inch in length on a 10-in. pipe does not seem very great. The outside diameter of the pipe is varying through this space of half an inch, and any method which would make precise allowance for this variation will be too complicated for common use, for the form of the thread is not a perfect *V*, and then the thread itself is cut on a taper. It would not seem unreasonable to select a diameter which is a geometric mean between the outside diameter of the uncut pipe and the diameter at the bottom of the thread. If greater refinement is needed in any particular case the actual length of exposed thread should be determined upon.

The bending moment at the support is the maximum that is allowable at the bottom of the thread after allowing for the stress coming from steam pressure, as already explained, and this bending moment determines the maximum allowable angle at the outer end of the thread. The expression for the tangent of this greatest angle is

$$\frac{w\ l^2}{2\ E\ I}$$

and since $m = w\ l_1$, and $\frac{m}{I} = \frac{2\ X_t}{d}$, this angle becomes

$$\frac{X_t\ l_1}{d_t\ E},$$

l_1 having a value depending upon the number of threads to the inch cut in the pipe; if 0.5 in., which was the value chosen for pipes from 2½ ins. to 14 ins. diameter, be substituted for l_2, the expression becomes

$$.0000001786 \frac{X_t}{d_t}.$$

Now, if this tangent be multiplied by l, the length of the branch, the result is a deflection v_2, so

$$v_2 = .0000001786 \frac{X_t}{d_t} l,$$

and this deflection will take care of the expansion in the length of main L_2, such that $v_2 = .00125\ L_2$. Accordingly, the relation between l and L_2 is expressed by the equation

$$L_2 = .00001429 \frac{X_t}{d_t} l,$$

and the deflection shown in Fig. 2 will provide for this length. The whole length of main is clearly the sum of L_1 and L_2; that is, $L = L_1 + L_2$, so the whole equation becomes

$$L = .000009524\ X_t \frac{I_t}{I} \frac{l^2}{d_t} + .00001429 \frac{X_t}{d_t} l,$$

and the numerical value for each term on the right-hand side of the equation is known for each size of pipe.

Eight-inch standard-weight pipe with 150 lbs. steam pressure gives the following values for the terms in the equation: $X_t = 14{,}783$; $I_t = 52.40$; $I = 72.02$; $d_t = 8.46$; so the equation for 8-in. pipe may be written:

$$L = .01210\ l^2 + .02496\ l,$$

which is easily solved for given values of l, units being in inches. If l be 100 ins., L becomes $100^2 \times .01210 + 100 \times .02496$; that is, 123.5 ins. for length of main pipe. If l be made equal to L, both values become 85 ins.; that is to say, 85 ins. is a limiting short length of main if the main be 8 ins. diameter. If the main be shorter than this, the effect of expansion of the branch upon the main will overload the latter. Recourse may be had to bending the branch pipe in such a way that its increased length shall not affect the main adversely, but this will in itself allow of a longer main being used. The consideration most important is that with 8-in. branch pipe, threaded as described, and connected straight into a straight main line, the branches cannot be shorter than 85 ins. without some part of the system being loaded to an amount greater than 16,000 lbs. per square inch.

These figures may with interest be compared to the corresponding figures for 8-in. pipe, which preserves its full strength at the joints; that is, which is not weakened by the cutting of the thread. In the uncut pipe the length of main corresponding to the 100-in. branch is 167 ins., which may be compared with 123.5 ins. for threaded pipe; and the limiting length for full-strength pipe is 60 ins., while in threaded pipe it is 85 ins. These comparisons show clearly the great disadvantage in threaded joints, particularly for the larger sizes of pipe. It is not difficult to make a threaded joint hold steam if it can be kept from moving. While this is true for any form of joint, it requires less to make the threaded joint move, and the threaded pipe is abundantly strong to resist steam pressure, too.

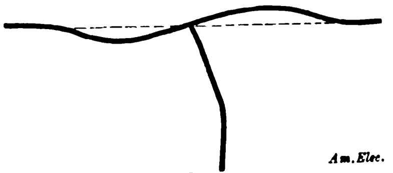

FIG. 3.

Thus far in this discussion no allowance has been made for the spring in the main itself. The maximum bending moments in the branches have been found at their ends, and these bending moments must be resisted by forces within the the body of the main pipe and within the nozzle to which the pipe is connected. In the case of the main, bending moments are produced which will tend to make it take the forms shown in Fig. 3, which is shown much exaggerated, the change in form of the main making it unnecessary for the branch to do all the bending, and therefore allowing of a slightly shorter branch. Usually, however, the branch is connected to a tee, which is itself very stiff, and the deflection of the main cannot be very great. If in any particular case it is of sufficient importance, it may be computed. In neglecting it the trifling allowance is on the safe side.

THE ADVANTAGES OF MECHANICAL DRAFT.

BY H. F. SCHMIDT.

For the combustion of any fuel a definite volume of air is required, and in any case where power is to be developed by such combustion of fuel in a furnace the problem at once arises how the necessary amount of air shall be supplied, and if more than one way exists, which of them is the most practical and economical.

Draft can be produced in two different ways; first, by reducing the pressure above the grate so that the pressure of the atmosphere forces air through the fire, which is called the "induced draft" system; second, by increasing the pressure in the ash pit, which is known as the "forced draft" system. The first of these, which includes chimney draft, has the disadvantage that the greater pressure without the setting, unless the boilers are internally fired, causes cool air to flow in through any cracks and porous bricks, which may cause considerable damage to the boilers and very materially reduce the temperature of the gases, resulting in a loss of heat up the stack and loss of efficiency of the gases to transmit heat to the water surfaces. While this would appear of little account, it has been shown to very considerably reduce the evaporative power of the boiler; however, by carefully constructing the setting this loss may be reduced to a negligible amount. Also, when mechanical induced draft is employed the draft machinery is necessarily situated in the path of the hot gases, causing rapid wear, as in many cases lubrication is almost impossible, although by the use of water-cooled bearings, such as that shown in Fig. 1, or some other arrangement, the question of temperature of the gases handled need not be considered. The advantages are that it is easiest to regulate and is the cleanest and best adapted for the use of economizers, air heaters, retarders, serve tubes, etc.

It is to be observed that as the density of the flue gases is directly proportional to the absolute temperature, it is not advisable to greatly lower their temperature by the use of economizers or air heaters when a chimney is depended upon to induce the draft, as in such cases an extremely high chimney would be required, interest on the cost of which might, in some cases, exceed the gain due to the economizers. Forced draft, on the other hand, offers the disadvantages that if cracks or porous bricks exist in the setting the fire room will always be more or less filled with coal gas and will be hotter than with induced draft, and the ashes are blown into the room when the ash-pit doors are opened. It, however, offers advantages on the score of smaller space being occupied, less air needing to be supplied, and as combustion is more perfect the higher the pressure, as the air comes into more intimate contact with the fuel, it has apparently higher efficiency.

Natural draft would at first seem to be the most economical, for, as is well known, after the chimney has once been erected it costs practically nothing for repairs and needs little attention. It costs nothing to operate except the heat used to cause the draft—a point of great importance and generally forgotten by those in charge of a plant. Also, in cities it is often necessary to deliver the products of combustion at such an elevation that they may cause no nuisance, so that such high chimneys are needed that other means of producing draft need hardly be considered; but when the plant is of great size and the cost of the chimney is divided among a large number of units it becomes a question of calculation whether mechanical draft shall be resorted to to aid the chimney or not. With chimney draft, however, there is a constant change in the draft, caused by atmospheric conditions, as all who have worked in a boiler room will know, and the quality of coal which may be burned depends upon the height of the chimney, which must be so great, if cheap fine coal is to be used, that the cost may be prohibitive; besides, in many places the cost of securing a suitable foundation would exclude the use of a chimney. There is another element which enters into the problem, namely, that of the growth of the plant and the possibility that with such changes the old chimney would no longer be used, under which conditions the entire investment in the stack would be lost.

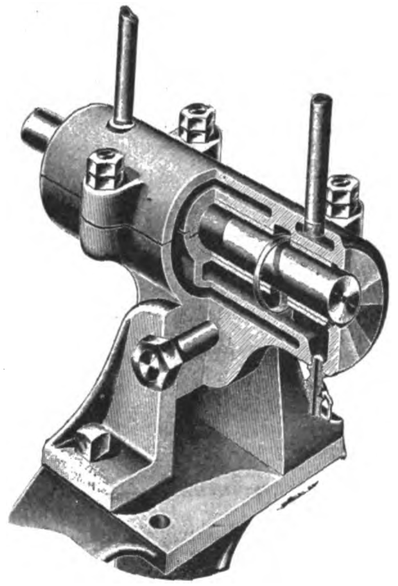

FIG. 1.—WATER-JACKETED JOURNAL BOX.

With mechanical draft the plant is entirely free from the limitations of climatic conditions, sufficient draft to burn the finest and cheapest coal being as readily obtained on a muggy as on a clear, cold day, and any increase in the demand of the plant may easily be met by an increase in the speed of the fan; this enables the plant to take care of the "peak" of the load during busy hours without so much difficulty. Cheap fuel may be used, and though probably of lower calorific value the reduced cost more than balances, and in most cases the saving from this source will more than pay for the installation of the mechanical draft apparatus in a single year.

Where, as outside of cities, high chimneys are not compulsory, the cost of a stack may be reduced by installing a draft machine at small cost, and furthermore with artificial draft the sectional area of the stack may be much less than with natural draft; while in cities, where ground space is very valuable, the omission of the chimney may result in a very considerable saving. Another important question in cities is the smoke nuisance. In many places the health authorities have prohibited the use of soft coal, but with properly designed forced draft apparatus smoke may be almost entirely prevented; certainly to such a degree that even bituminous coal may be used without objection.

The great economic point in favor of mechanical draft is that the air rushing through the fuel under greater pressure than with natural draft, comes into more intimate contact with the fuel, as above stated, so that less air is required than with natural draft. The results are a higher temperature of combustion and a consequent increase in evaporative efficiency, as the rate of transfer of heat is proportional to the difference between the temperature of the water and that of the furnace gases. Again, it is evident that the temperature of the gases rejected at the stack remaining constant, the loss of heat through the chimney is directly proportional to the volume of air admitted below the grates. From a great number of experiments it has been found that a reduction of the grate area, and an increased rate of combustion per square foot of grate, results in an increase of efficiency for the reasons given in the preceding paragraph; but this may only be accomplished when some means of securing the necessary draft is supplied.

When with natural draft, fresh fuel is put on the fire, the effective draft pressure is reduced, owing to the layer of fresh fuel, and consequently the air supply is reduced just at the time when it should be greatest; the result of which is that some of the gases distilled from the fuel, not being hot enough and lacking the necessary air for combustion, pass up the chimney unburned. With mechanical draft, on the other hand, just the reverse is true. When fresh fuel is put into the furnace the speed of the fan is automatically increased, giving a plentiful supply of air, which gradually grows less as the fresh fuel ignites, until a fresh charge of fuel is put on the fire, when the same cycle is again repeated, adding greatly to the economic performance of the furnace and the maintenance of a constant boiler pressure.

There are a few slight objections which might be raised against mechanical draft; among them are the necessary use of fans (other apparatus being seldom used) and their attached engines, which are subject to rapid deterioration, being of the high-speed type and exposed to the dust and grit of the boiler room, and requiring oil and attendance; but on the other hand, as will be shown later, they are more economical in the use of heat (coal) to produce the same effect as a chimney, and are obtainable at a much less first cost. It may be argued that they take up valuable space and are noisy, but this can generally be met by the fact that they may be placed above the boilers or hung from the ceiling, besides which they obviate the use of a chimney. Again, it will at once occur to the reader that a steam engine or other motor is liable to break down. While they should be quite secure against accidents, if of a reliable make, there is always a possibility of breakdowns, in which case the plant would be compelled to shut down, as draft could not be obtained without a chimney, but this may be provided against by installing a duplicate set of draft producers.

In order to investigate the comparative efficiencies of a chimney and fan for producing draft, let us consider the case of a chimney 180 ft. high, 10 ft. in diameter, having a transverse flue area of 87.54 sq. ft., and assume the temperature of the atmosphere to be 62° F., and that of the escaping gases to be 500° F., neglecting friction in the stack and substituting air of the same temperature as the furnace gases in place of them. The density of air at 62° F. is 0.0761 = *d* and the density of air at 500° F. is 0.0414 = *d'*. Then from the formula for the pressure produced by a chimney of given height, $p = h\ (d - d')$, the draft pressure will be 180 (.0761 — .0414) = 6.25 lbs. per square foot of area. Hence the pressure over the entire area of the stack will be 6.25 × 78.54 = 490.87 lbs. The height of a column of air necessary to produce this pressure per square foot will be expressed by the formula

$$H = h\left(\frac{d - d'}{d}\right)$$

and substituting values we have

$$H = 180\left(\frac{.0761 - .0414}{.0761}\right) = 82.1 \text{ ft.}$$

The velocity caused by this head is

$$v = 8.025\sqrt{H}$$
$$= 8.025\sqrt{82.1} = 72.71 \text{ ft. per sec.}$$

Hence the weight per second will be 72.71 × 78.54 × .0761 = 434.6 lbs., but work has been done equal to the velocity times the pressure = 490.9 × 72.71 = 35,690 ft. lbs. per second, which is the useful work, but this work was performed by raising the temperature of the gases from 62° F. to 500° F., that is through 438° F., so that the total work done is equal to 434.6 × 438 × 0.2375 × 778 = 35,157,000 foot pounds per second, 0.2375 being the specific heat of air at that temperature. Hence the efficiency of the system is

$$\frac{\text{useful work}}{\text{total work}} = \frac{35{,}690}{35{,}157{,}000} = 0.001015$$

The actual efficiency of the chimney would fall far below this in practice, due to the cooling effect of the stack, friction, etc. Now suppose we intend to do this useful work with a fan. Assuming a very low efficiency for the fan, namely, .5, then the actual horse-power required to drive it would be

$$\frac{35{,}690 \times 60}{0.5 \times 33{,}000} = 32.45 \text{ h. p.}$$

Allowing a steam consumption of 50 lbs. of steam per horse-power per hour, steam at 150 lbs. per square inch, feed water at 100° F., and a boiler efficiency of 80 per cent, the total heat units required by the engine would be 32.45 × 50 × 1123 ÷ 0.8 = 2,277,000 per hour or 633 B. T. U's per second, where 1123 is the number of B. T. U's per pound of steam, against 45,210 B. T. U's per second used by the chimney to perform the same work. Finally we obtain the relative efficiencies from the fraction

$$\frac{\text{total heat units used by chimney}}{\text{total heat units used by engine}} = \frac{45{,}210}{633} = 71.3;$$

that is the fan is 71.3 times as efficient as the chimney. It is not to be understood that by using a fan the entire heat wasted in the stack would be saved, but this loss may be greatly reduced. In place of supplying 300 cu. ft. of air per pound of coal burned, as with chimney draft, only 180 to 250 cu. ft. is needed. Hence, in the example just cited, had the air supply been assumed at 300 cu. ft. for natural draft and say 225 for artificial, the saving in heat units would have been

$$(434.6 \times 0.2375 \times 438) - \left(\frac{225}{300} \times 434.6 \times 0.2375 \times 438\right) = 11{,}302.5 \text{ per second;}$$

a neat little economy which would in one year pay the cost of the draft apparatus on a plant of this size, and the cost of running, which would be too small to be considered if the exhaust steam from the fan engine were used for heating.

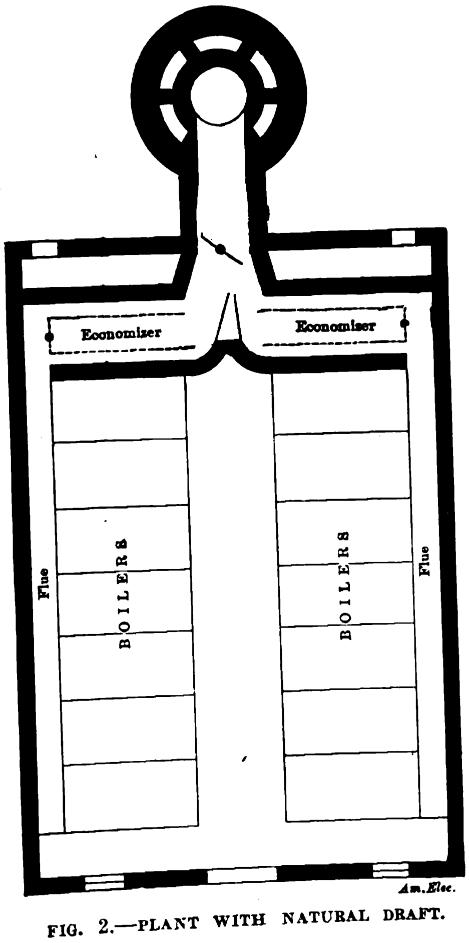

FIG. 2.—PLANT WITH NATURAL DRAFT.

First cost of a plant is, of course, of great importance in regard to the financial efficiency, and it is on this point, if upon no other, that the real value of mechanical draft depends. The following example will indicate the financial gain resulting from the use of mechanical draft. Figs. 2 and 3 represent a plant of 3500 horse-power of modern water-tube boilers of 250 horse-power each, arranged in two rows and fitted with economizers. In Fig. 2 the chimney is 11 ft. internal diameter and 180 ft. high, and in Fig. 3 the same plant has duplex fans for induced draft installed on a platform above the economizers, in place of the chimney. This illustrates what has already been said in regard to saving valuable space occupied by the chimney.

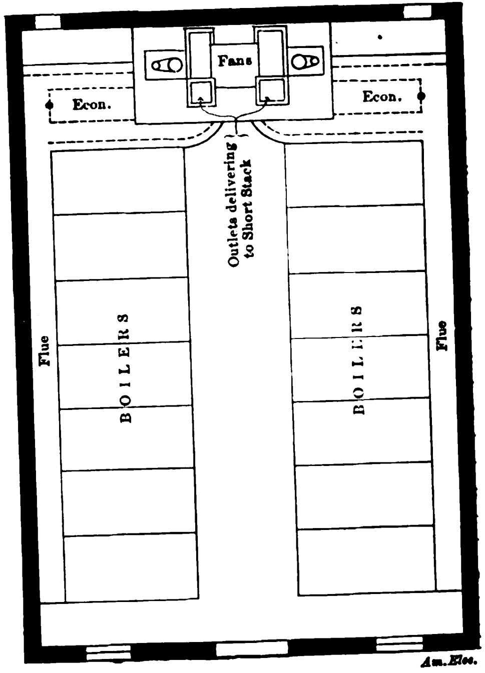

FIG. 3.—PLANT WITH INDUCED DRAFT.

In round numbers the cost of the plant is in detail as here shown:

Cost of Boiler Plant, With Chimney.

14 water-tube boilers	$44,500
2 economizers	15,200
Boiler and economizer settings and by-pass	13,000
Cost of chimney and foundation	12,600
Boiler house	15,000
Dampers and regulator	500
	$100,800

Comparative Costs.

Chimney Draft.			
Cost of chimney and foundation	$12,600	Cost of mechanical draft plant complete	$6,300
Dampers and regulator	500	Saving by use of mechanical draft	6,800
Total	$13,100		$13,100

This reduction in the first cost of the plant will alone, at a rate of 5 per cent interest, result in a yearly saving of $340, besides, as will be shown later, the saving possible by burning a cheaper grade of fuel.

The question which usually sooner or later comes up is that of increase in the capacity of the plant. Suppose it is desired to increase the capacity of the above plant to 4000 horse-power, a moderate increase of 14 1/3 per cent, one will then have a choice of two methods in which to increase the capacity. First, two additional boilers may be added; or, second, the existing boilers may be forced by replacing the existing fans by larger ones. The relative cost of these two methods is approximately as follows:

4000 H. P. Chimney Draft.		3500 H. P. Mechanical Draft.	
Two additional boilers	$7,750	Fan, dampers, etc.	$1,700
Settings, etc.	1,300	Saving by use of mechanical draft	10,100
Addition to building	2,750		
Total	$11,800		$11,800

A similar calculation would show the saving resulting from the omission of two of the original fourteen boilers, and obtaining the 3500 horse-power by forcing the twelve boilers; and it will occur to the reader that should two of the boilers, or even three, become disabled or damaged, the full capacity of the plant could still be obtained by a mere increase in the speed of the fan, with no great loss of efficiency.

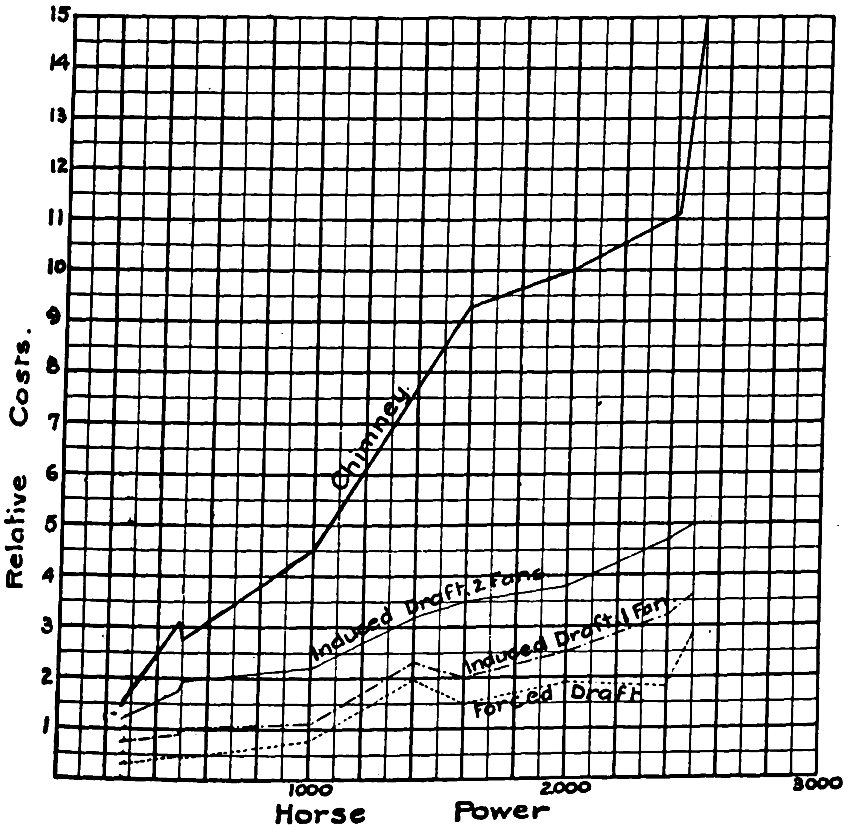

FIG. 4.—CURVES OF COMPARATIVE COSTS.

Fig. 4 presents a set of curves which was prepared by Mr. W. B. Snow showing the comparative cost of nine plants for forced, induced, duplex induced, and chimney draft; and it will be seen that the duplex induced draft machinery costs but about one-third of an equivalent chimney. Assuming a consumption of 3.2 lbs. of Cumberland coal per horse-power per hour; Mr. Barrus' value of 0.8905 for the relative value of Cumberland and a mixture of two parts pea and dust to one part of Cumberland, Cumberland being taken as unity; and the wages of the fireman at $1.75 per day and helpers at $1.25 per day, the cost of running the 3500 horse-power plant with the above-mentioned fuel for ten hours will be about as follows: $3500 \times 3.2 \times 10 = 11{,}200$ lbs. = 50 tons of 2240 lbs., which makes the cost of the coal equal to $50 \times \$4.50 = \$225$. Adding to this the cost of labor of seven firemen and five helpers, we have the total cost for ten hours to be, $\$225 + \$12.25 + \$6.25 = \$243.50$.

For a run of ten hours, using the mixture of two parts pea and dust and one part Cumberland, the cost would be $3.2 \times 3500 \div .8905 \div 2240 \times 10 \times \$3.30 = \$185.46$, and adding to this the wages of nine firemen and seven helpers, the total cost will be $\$185.46 + \$15.75 + \$8.75 = \$209.96$; hence, the daily saving due to the use of the mixture in place of the Cumberland will be $\$243.50 - \$209.96 = \$33.54$, which amounts to $201.24 per week. To show that the above may easily be obtained in actual practice, a certain plant of 1000 horse-power, in which the above change of fuel was made, resulting in a saving of $126 a week, serves as ample proof. In the latter case the gain was far greater than was calculated in the preceding paragraph. However, to burn the mixture efficiently, either an excessively high chimney or mechanical draft would be necessary, and as it has been shown that of the two mechanical draft is by far the cheaper, it would be used.

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Municipal Control at Worcester, Mass.—The committee of the Worcester Common Council appointed to consider the advisability of purchasing the plant of the local lighting company, reported adversely. A thorough study of the situation was made and the committee showed by reference to plants in some 17 cities that the city could not better the service or prices it was now receiving from the company.

RECONSTRUCTING AND MODERNIZING CENTRAL STATIONS.

BY O. M. RAU.

Improvement in apparatus has been so rapid that before changes to new apparatus made in years past were completed they became obsolete.

With this condition there is some excuse for the obsolete apparatus in operation in the majority of smaller central stations throughout the country, the inefficiency of which makes the problem of the advisability of reconstruction one of simple mathematics.

The highest development has by no means yet been obtained in perfecting electrical generating apparatus and methods of distribution, but there are a number of definite conditions which can be acknowledged as sufficiently developed to leave little doubt of their permanency, and that future development will be in minor details which would not depreciate the apparatus in anything like the proportion the improvements of the past five years have. For this reason any of the old plants which have been holding on to their old equipment with the hope of making no mistake in changing to the best, should not hesitate to act, as the depreciation on old equipment is rapidly increasing. An old plant with an assortment of varied apparatus presents a difficult problem, but a short time ago the solution would have been more difficult than it is now.

Recent alternating current developments have demonstrated that for the average central station (and isolated plants might also be included), the flexibility of alternating current leaves little to be desired, and for covering the unlimited demand that may come within the scope of a modern central station it is perfectly suited. The efficiency of all apparatus in connection with alternating currents has reached a stage of perfection where no other class of service can equal it, and its application for commercial purposes is universal, with the exception of the direct charging of storage batteries, which, at present, is not a defect to be seriously considered.

To-day the solution of reconstruction problems is a relatively simple one, and has none of the questionable points to cause delay in obtaining its proper solution that confronted the manager formerly. A single generator, covering all classes of service desired, takes the place of the former assortment, and either direct connected or direct belted solves the shafting problem. If the generator is obtained large enough, so that the engine is the weaker part of the unit, in case of a heavy overload or short circuit this excess of capacity is a valuable safeguard against its destruction.

Reconstructing a plant on these lines means abandoning all generators and installing one or two (preferably two, belted direct from separate engines) three-phase alternators of the 4-wire type, giving 2,000 volts potential between each main wire and the fourth or neutral wire. This generator can be used to supply various classes of service from the separate phases, taking for instance the commercial incandescent and arc lights in the business district from phase number 1 to neutral, installing at a convenient location close to the center of load a large transformer or bank of transformers, preferably placed in a manhole underground, instead of attempting to hang the enormous weight of the larger transformers on poles, where they are a continual source of anxiety and danger, as well as unsightly.

These transformers are to be connected to a secondary 3-wire distribution system, and if the plant was previously operated on the direct current 3-wire system, no better network could be desired to which to connect the transformer. The primary side of transformer would receive the current at approximately 2,000 volts through a feeder from phase number 1, as stated before.

The outlying commercial business would be taken care of by phase number 2, similarly to the present method of single phase distribution, by placing separate smaller transformers at such points as will serve the largest number of customers, or when distances become too great, a transformer for each customer. But in all cases the three-wire secondary should be strictly adhered to, so that as the city expands and the business district grows, each secondary network may become part of the main secondary distribution system. All service should be three-wire wherever practical.

From phase No. 3 the city arc circuits through constant current transformers can be served, and with alternating-current series enclosed arc lamps the highest economy as well as the most satisfactory street lighting can be obtained. These transformers can be located in the main power-house, or at transformer stations, centrally located in the lighting districts. In the latter case any shed, store or basement space could be utilized. Or if desirable they could be placed in underground manholes similar to the transformers for the commercial circuits, although special attention must be paid to ventilation and drainage.

The trimmer of the route centering at a transformer station should be held responsible for this station, and be required to start the lights by closing the circuits at these transformers at the proper time. This will insure reliable service, and avoid any difficulties that are encountered if started from the main station, where they can readily be shut down, however, by opening the primary circuit.

For the power circuits a separate three-phase feeder would be required from which power for motors would be taken, using a group of three transformers with a Y connection on the primary side and a delta connection on secondary side reducing the approximately 4,000-volt primary to 220-volt secondary. These transformers should be located so that the three-phase secondary circuit would reach a number of power customers, as the installation of a transformer for each customer is very expensive. By the use of three-phase motors all trouble from excessive starting currents is overcome, and motors of any capacity within the range of the generating station can be successfully operated without any material effect on the incandescent circuits.

The most important feature of this method of distribution is the absolute control of each system, and the perfect regulation which can be obtained, irrespective of the unbalanced condition of the load. The series arc system being automatically taken care of by the constant current transformer, the three-wire power circuit is not materially affected by variable loads, while on the commercial lighting circuits, regulating transformers giving a range of 10 per cent above or below the generator potential can be placed in each feeder, and by means of a hand wheel constant potential can be maintained under all conditions of load.

In some instances a source of revenue is available at a considerable distance from the station. Perhaps a neighboring town, too small for an independent plant, a manufacturing plant, or some institution too far distant to be reached economically by the ordinary 1000-volt system. In this case a feeder of two wires from one of the phases is used, giving a potential of approximately 4000 volts, at which pressure the feed wire becomes a small factor and a considerable distance can be economically reached. By using two standard 2000-volt transformers with primaries in series and secondaries connected for standard voltage, using the three-wire secondary distribution system such business can be successfully taken care of.

In advocating the three-wire secondary distribution system many points of advantage are obtained, the most important being the availability of 220-volt current at all services. Not only is there a tendency to increase the voltage of incandescent lamps little by little, but the time is not far distant when a 220-volt lamp will be as efficient as those of lower voltage, and with the supersedence of the multiple enclosed arc lamp by the Nernst lamp, the advisability of providing 220 volt secondary service cannot be questioned.

In preparing these few remarks my object was to point out a plan of reconstructing the many smaller central stations which are operating with old, inefficient apparatus, the value of which is so rapidly depreciating that most of it can only be appraised at scrap value, the owners of which have been delayed in taking action due to the rapid change made in electrical apparatus, and I hope my suggestions may help to decide this perplexing question.

[The foregoing is an abstract of a paper read at the January convention of the Northwestern Electrical Association.]

Some Features of the Manhattan Elevated Railroad Company's Station Equipment.

The work of providing electrical equipment for the Manhattan Elevated system in New York City has progressed to a point where the regular operation of trains on one of the lines has commenced. The gigantic power house has, of course, been completed for some time, and work has been pushed as rapidly as possible upon the construction of the mammoth generating units and the steam plant which are to occupy the building. During the past month one of the generating units has been started up, and a few trains put in operation on the Second Avenue line; other equipments will be put into service just as rapidly as they can be obtained and mounted.

The present boiler equipment comprises 64 Babcock & Wilcox horizontal water-tube boilers of 525 horsepower each, arranged in batteries of two each, and designed for 200 lbs. working steam pressure. The number of boilers will be increased ultimately to 96, making this the largest boiler plant ever designed or installed. Roney mechanical stokers are being installed in the plant by Westinghouse, Church, Kerr & Co. It was estimated by the engineers for the Manhattan Company that at least 270 men would be required to fire these boilers by hand, whereas with the mechanical stokers only 90 men will be required, effecting a saving in labor alone of $400 per day. The present installation will consist of 256 stokers under the 64 boilers, and they will be capable of steaming the boilers at 50 per cent above their rated capacity. The total equipment when the plant is completed will consist of 384 stokers. Sixteen Green fuel economizers are employed, one for each pair of batteries of boilers. They are of the high-pressure type and aggregate 8192 tubes.

Huge stacks have been erected, of sufficient dimensions to furnish enough draft for ordinary requirements, but as a precautionary measure 16 blowers, built by the B. F. Sturtevant Company, were installed, to furnish forced draft when needed. These blowers will be operated by Westinghouse induction motors. Eight triplex single-acting boiler-feed pumps of the Goulds type are driven by 500-volt direct-current motors.

The generating equipment consists of eight 5000-kw. Westinghouse alternators direct-connected to Allis-Corliss engines.

Fig. 1, which gives a partial view of one of these sets, will convey some idea of the massive character of the machines. They have a nominal rating of 5000 kilowatts, but have a maximum capacity of 10,000 horse-power, and are the largest electrical generators that have ever been erected.

The steam engines were built at the Allis shops in Milwaukee, after design of Mr. Edwin Reynolds, and each consists of a pair of compound engines working upon a common shaft, the high-pressure cylinders being horizontal and the low-pressures vertical; the high-pressure and low-pressure pistons of each half drive the same crank-pin. The dimensions are given on the following page.

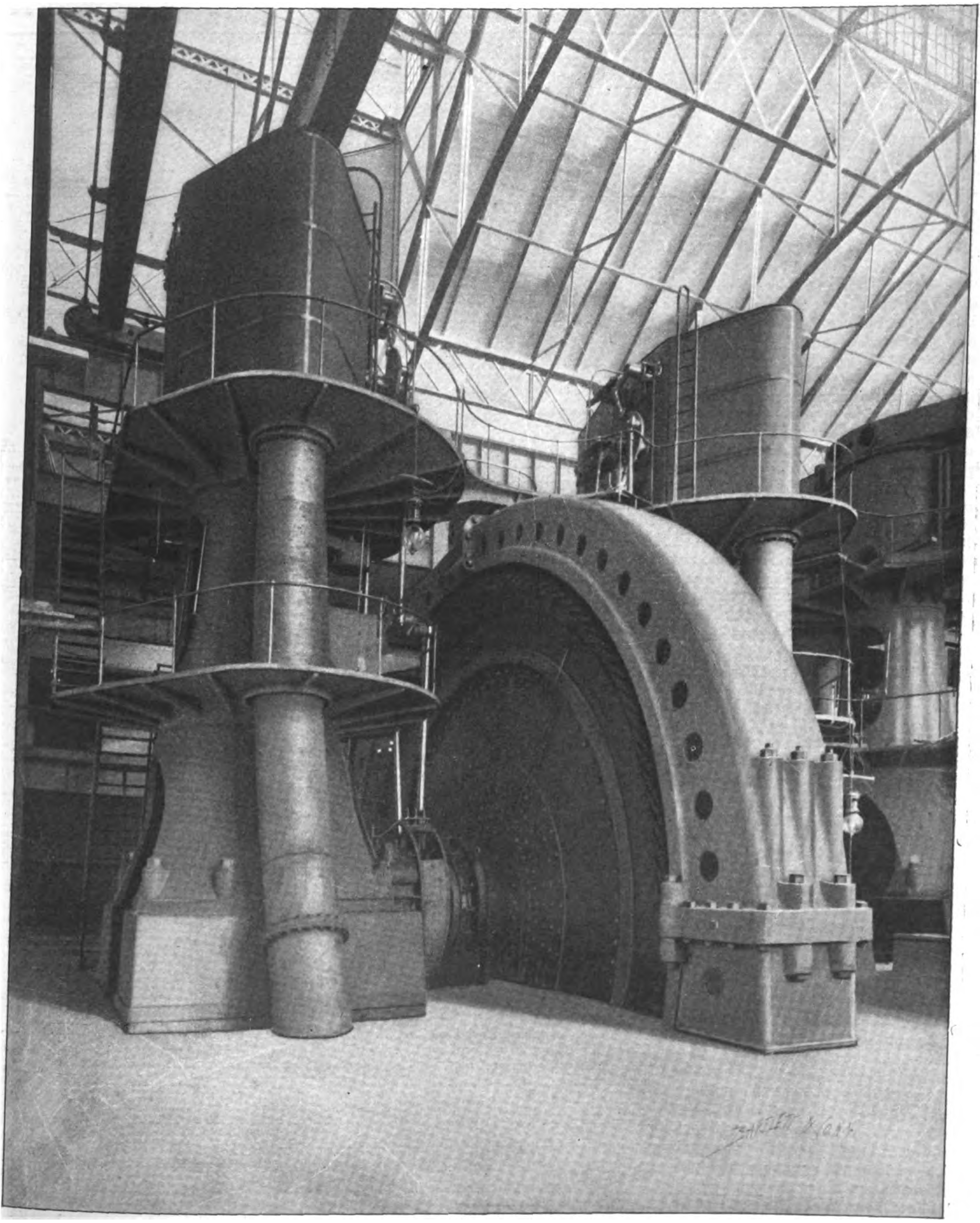

FIG. 1.—ONE OF THE 5000-KW. UNITS IN THE MANHATTAN ELEVATED RAILWAY POWER STATION.

Diameter high-pressure cylinders	44 ins.
Diameter low-pressure cylinders	88 ins
Ratio of piston areas	4
Stroke common to all	5 ft.
Rate of turning	75 r.p.m.
Piston speed, feet per minute	750
Diameter piston rods	8 ins.
Displacement of both low-pressure cylinders, cubic feet per minute	63,094
Horse-power per pound of M. E. P. referred to low-pressure cylinders	275.92

The capacity of the engines is from 7500 horse-power to 12,000 horse-power. To get this capacity into a two-cylinder engine of the ordinary cross-compound type would require cylinders 62¼ and 124½ ins. in diameter. By the use of four cylinders each crank is given four instead of two impulses within each revolution. If the cranks were set square, or in line with each other, at 90° or 180°, the impulses upon the two pins would coincide, but by setting one crank half way between, square with and opposite to the other (at 135°), the shaft receives eight impulses per revolution, which gives an extremely uniform turning effort to the shaft. This arrangement at the same time prevents any dead center, and enables the operator to start off a unit from any point without any attention to the position taken by the cranks in stopping. The advantage of a vertical position is retained for the large low-pressure cylinder; the only complication introduced being the attaching of two connecting rods to a single overhanging crank-pin.

Steam jackets are not used, but the placing of the valves in the heads of the low-pressure cylinders leads to a partial jacketing effect in those heads. The ordinary Reynolds-Corliss valve gear is employed, with a single eccentric on each high-pressure cylinder and separate eccentrics for the steam and exhaust valves of each low-pressure cylinder. The two sides of the engine are entirely distinct, and one can be run with the other uncoupled without affecting its steam efficiency.

Steam is delivered to the high-pressure cylinders at 150 lbs. gauge pressure by 14-in. mains. From the high-pressure cylinder the steam passes through a 16-in. pipe to a vertical receiver, which is virtually a downward prolongation of the steam chest of the low-pressure cylinder. A separate receiver is provided for each side, containing 773 sq. ft. of reheating surface, composed of 2-in. copper pipe, traversed by steam at boiler pressure. From the receiver the reheated steam passes, of course, to the low-pressure cylinder, which exhausts through 30-in. pipes combined into one 40-in. main leading to the condenser, one condenser being provided for each complete unit.

The pistons are rectangular in cross-section, with bull and packing ring and follower, all heavily ribbed, screwed on to the rod with a jam-nut and keeper. The rods are all 8 ins. in diameter, of open-hearth steel, screwed into the cross-head as well as into the piston. The Allis-Reynolds cross-heads have been modified and provision made for fastening the babbit-lined shoe to the body of the cross-head in addition to the usual studs of the adjustable wedges. The connecting rods of the vertical and horizontal cylinders are of the same length, namely, 5.4 crank lengths. They are of open-hearth forged steel, with a solid end in the cross-head and strapped at the crank-pin end. The cross-head pins are 12 x 12 ins. and the crank-pins 18 x 18 ins., or 18 x 9 for each rod.

Each of the generators delivers three-phase currents at 11,000 volts, which, if necessary, may be raised to 12,000 volts. The wave form generated is practically a sine curve under all conditions of load and power factor. The regulation from no load to full load is guaranteed to be within 6 per cent. The rise in temperature of any part of the machine above the surrounding air under full load for 24 hours is not to exceed 35° C. (95° Fahr.), and at 50 per cent overload, or 7500 kilowatts, it is not to exceed 55° C. (131° Fahr.). The efficiency at full load from engine to switchboard is 96.5 per cent. The design of the engine-dynamo unit eliminates the usual auxiliary fly-wheel. The weight and dimensions of the revolving dynamo field are such, with reference to the turning moment of the engine, that any auxiliary fly-wheel is unnecessary.

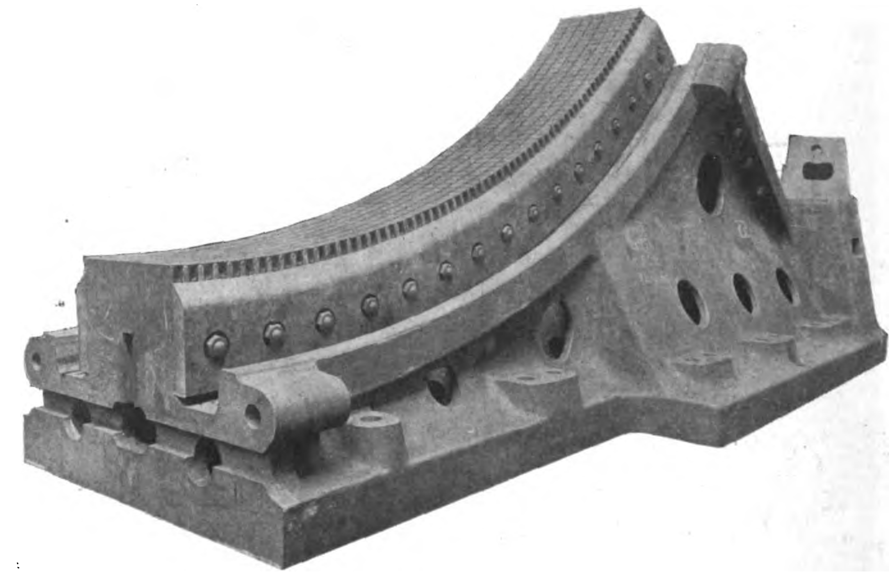

FIG. 2.—SECTION OF THE STATIONARY ARMATURE.

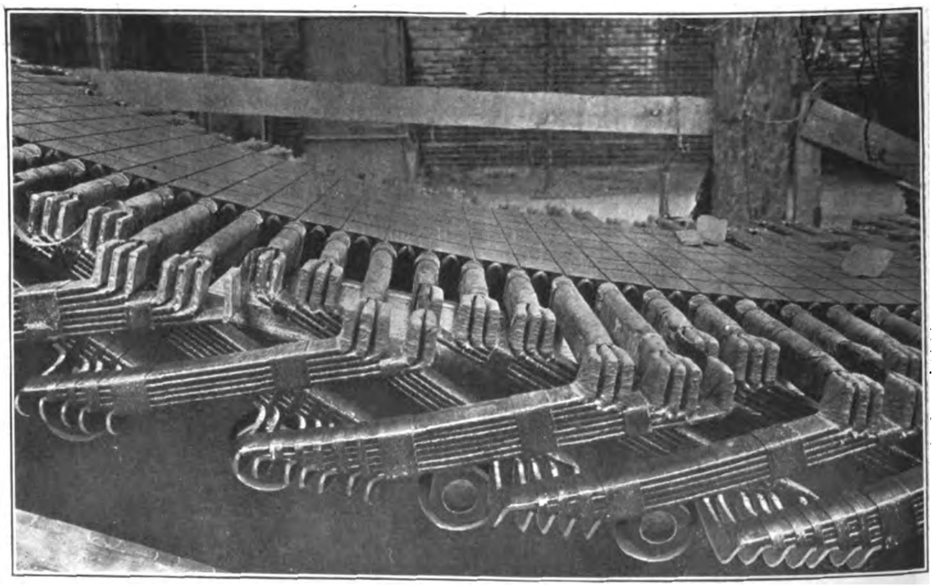

FIG. 3.—SECTION OF THE ARMATURE WINDING.

The hub of the revolving field, which is also the fly-wheel of the engines, is of cast steel, and the rim is carried not by the ordinary spokes but by two webs of rolled steel. This revolving field is 32 ft. in diameter at the air-gap, and in operation has a peripheral speed of 7540 ft. a minute. Its weight is 370,000 lbs. There are 40 poles, built up of laminated steel. They are wound with copper strap on edge, one layer deep, and the insulating material is cemented in place between the turns. The edges of the strap are exposed in order better to dissipate the heat developed. The normal exciting current for each alternator field is approximately 225 amperes at 200 volts, and the winding is so designed that the excitation can be increased to care for an overload of 50 per cent and a 90 per cent power factor. The field windings are held upon the poles by copper wedges driven between the pole tips, which also serve as "dampers" to prevent the shifting of the magnetic field, and hence preserve constant the wave form generated.

The armature consists of six castings bolted together, to which is attached the armature core. The latter is a built-up ring composed of thin, soft steel plates, with slots on the inner surface in which are placed insulated copper bars constituting, with their end connectors, the armature winding. The steel plates are separated at intervals by ventilating spaces, in order to permit thorough ventilation of the winding and laminations. In order to produce a wave form free from irregularities, and of the same shape at different loads, a distributed winding with 4 armature slots and 12 conductors per phase per pole, was adopted. This tends to avoid the production of harmonics, which is an exceptionally important matter in view of the large capacity and self-induction of the extensive system of cables and transmitting apparatus, especially where a large number of 1500-kw. rotary converters are to be employed. Each slot contains three bars, which are insulated singly and then taped together. The bars in any slot may be removed without disturbing the bars in the other slots or any part of the framework (see Fig. 3). The armature conductors are insulated to withstand a puncture test of 25,000 volts alternating current for thirty minutes. The weight of the completed machine is 900,000 lbs., its height 42 ft. Fig. 4 gives an idea of the hugeness of the structure.

Current for exciting the fields of the alternators will be supplied by a battery of four 250-kw. exciters, also of Westinghouse build. These exciters are of the engine type, the armature and commutator of each machine being bolted together upon a ventilated cast-iron sleeve and pressed upon the engine shaft.

It is proposed also to install rotary converters and transformers at the central power station for furnishing current for operating motors and the lighting plant. Altogether the lights and motor service from the plant, aside from the car equipments, will require as much current as many central stations in fair-sized cities.

The current is to be distributed over the entire system of the Manhattan Railway, including 37 miles of road in the boroughs of Manhattan and the Bronx. The potential at which it leaves the power plant is 11,000 volts, and eight sub-stations have been erected at convenient points along the lines of the road, where transforming apparatus is installed to reduce the voltage to proper value for use. The general arrangement of all sub-stations, and the distribution of apparatus, are similar, so that an operator familiar with one station can perform duty at another when required, without any special training. The rotary converters are arranged in two parallel rows, and the transformers are located in groups of three upon galleries along the sides. There are 26 rotary converters and 78 transformers in these sub-stations. Each converter receives current from a group of three 550-kw. step-down transformers connected in delta, at a potential of approximately 390 volts. The sub-stations are located at unequal distances from the power station, and as all of the sub-stations are to be supplied with power from alternators operated in parallel, the effective potentials delivered by the high-potential distributing cables to the several sub-stations will differ. In order that the potential of the direct current delivered by the rotary converters shall be equal, provision for the adjustment of the ratio of transformation of the step-down transformers is made by means of loops brought out from the primary windings of the transformers. The transformers are of the air-cooled Westinghouse type. Motor-driven blowers are installed in each sub-station for supplying the necessary air. The guaranteed efficiency of the transformers at full load is 97.75 per cent. The overload ratings are proportioned to those of the rotary converters.

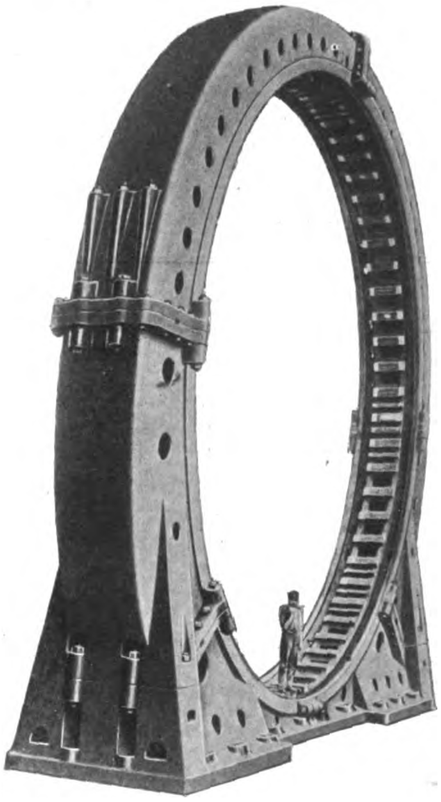

FIG. 4.—STATIONARY ARMATURE OF ONE OF THE GENERATORS.

The rotary converters are larger than any that have heretofore been constructed, having a nominal rating of 1500 kilowatts and a maximum capacity of 2250 kilowatts, or 3000 horse-power. Each converter is self-contained, the two bearings and the lower half of the field magnet frame being mounted on a common base. The magnet frame is divided in a horizontal plane. The machine has 12 poles, and when supplied with an alternating current of 25 cycles frequency, therefore, it runs at a speed of 250 r.p.m. The field is compound wound, the shunt winding being arranged for self-excitation. The output of the converter is delivered at a normal potential of 625 volts. The guaranteed efficiency at full load is 95.75 per cent.

The armature is of the usual slotted drum type, and the core is built of sheet steel of the best quality, forced upon a cast-iron spider. The armature winding consists of strap wound coils formed and insulated before being placed in the slots, in which they are held by retaining wedges of hard fiber. The winding is of the parallel type, forming 12 paths, and is cross-connected by balancing rings. The commutators are built of bars of hard copper, insulated from each other with mica. The number of bars is such that with a potential of 625 volts across the direct current terminals the average difference of potential between two bars will not exceed 12 volts. The copper brushes are held in brush-holders of the sliding-shunt type. The collector rings to which the alternating currents are delivered from the step-down transformers are of the Westinghouse open type.

The field magnet frame is of cast-iron and the pole-pieces are built up of sheet steel. The faces of the latter are beveled at the edges to allow the use of copper shields. The series winding is sufficient to compound the machine from 575 volts at no load to 625 volts at full load. The wave form of these converters is practically the same as that of the alternators. The converters are guaranteed to stand an overload of 100 per cent without "hunting," and may be overloaded to several times the normal full load without falling out of step. In the construction of these converters, the Westinghouse Company aimed to make the fly-wheel effect relatively small, so as to enhance the controlling effect of the copper shields. The total weight of each converter is 105,000 pounds, the height 13½ ft., and the floor space occupied is 13 ft. x 10 ft.

The converters are started on the direct current side, for which purpose a motor-generator set will be installed in each sub-station. The method of starting by direct current derived from these starting sets, rather than by current taken from the main direct-current bus-bars of the sub-station, was adopted in order to avoid undue magnetic and electrical strains in the converter, such as may easily result from a slight mistake of the operator, for example, in closing the synchronizing switches when the machines are not exactly in step.

Most of the alternating-current circuits are opened and closed by housed oil switches of the type shown by Fig. 5. All three phases are simultaneously opened by the raising of six copper rods fastened in pairs to a common yoke by three wooden rods; each pair of copper rods forms a circuit-closing ∩, so that there are two breaks in series in each phase. A small master switch closes the circuit through the series-wound motor on the switch housing and through the solenoid shown at the end of the motor shaft. The solenoid throws the worm of a worm gear into clutch with the motor shaft, the worm wheel being on the switch shaft; the motor, of course, starts up at the same moment. The gear wheel carries a crank pin, connected to the middle point of a toggle joint, off its dead center, and as soon as it is out of line a powerful spring closes the switch, carrying the crank-pin around through nearly 180 degrees. The moment the action of the spring ceases, a ratchet engages the crank-shaft and the crank-pin is carried through the remainder of the 180 degrees by the motor, which then switches itself out. This travel through the remainder of the 180 degrees compresses the switch-opening spring. To open the switch, the motor circuit is again closed, whereby the toggle is upset again and the switch flies open under the action of the powerful spring mentioned; this spring is supplemented by four extra springs, making the opening action quicker than the closing action.

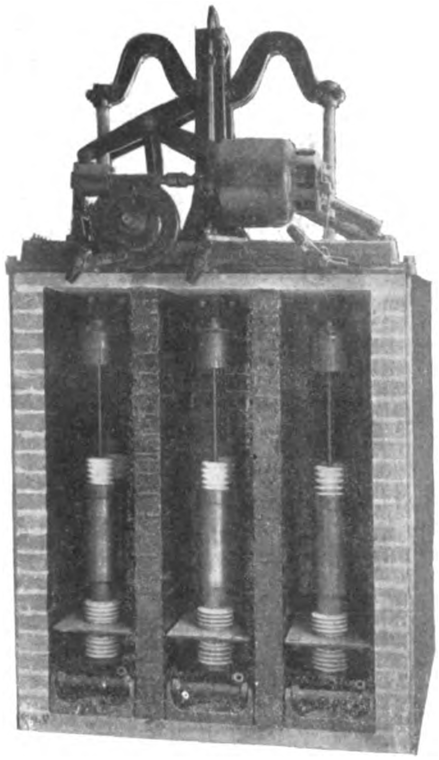
FIG. 5.—OIL SWITCH.

When the new equipment is completed it is estimated that two million passengers can be carried in a day by the elevated trains. This represents the movement of over two hundred trains daily, requiring an expenditure of energy varying from 5000 horse-power at the hours of minimum load to 60,000 horse-power at the hours of maximum load. To the engineer and the railroad expert the electrical equipment of the Manhattan Railway presents many points for consideration and study. The magnitude of the undertaking and the character of the work performed cannot fail to command universal attention. The fact that the conservative Manhattan management had sufficient confidence in the electrical equipment to substitute it for steam locomotives upon all its lines indicates beyond cavil that electrical engineering for heavy railway work has passed beyond the experimental stage. The influence of this work cannot fail to be lasting and far reaching in the general railway field.

TESTS OF CRUDE OIL AS FUEL.

A series of interesting tests of crude petroleum under horizontal return-tubular boilers was recently made in New York City by Prof. James E. Denton, of Stevens Institute of Technology, Hoboken, N. J. The tests were made in the boiler house of the West Side Hygeia Ice Company, which contains three return-tubular boilers, each 6 ft. in diameter by 18 ft. long. One of these boilers was fitted for the oil test, as indicated in Figs. 1 and 2.

Four ducts, *F*, of hollow tile, 10 x 10 ins., were laid in the ashpit, extending nearly to the bridge wall, and the ashpit door openings closed by brick work, *W*, around the outer ends of the tile. The forward bearer of the grate bars was dropped, about half of the forward set of bars removed, and a course of firebrick, *O*, laid with fire clay over the whole upper surface of the grates, so that air entering through the tile could flow back along the outside of the latter, and then around and up between the front end of the grate bars through an area a little greater than that of the aggregate cross-section of the tiles.

A checker work, *P*, of about 50 loose firebrick was built over the grates, the space back of the bridge was filled with ashes, *R*, flush with the top of the bridge wall, and a single-course floor, *Q*, of firebrick laid over the ashes. An iron bar, *a*, was bridged across the middle of the fire-door opening, and the remainder of the latter closed with firebrick, *V*, flared on the inside, a small opening, *L*, being left for applying the torch to the burners. Into the iron bar across each door was screwed the burner.

The oil was stored in an iron tank, *A*, 7 ft. in diameter by 5 ft. deep, sunk in the ground, into which the barrels in which the oil was received were emptied, from time to time, through the pipe, *C*. The top of the tank was closed, ventilation being afforded by the pipe, *Y*. A steam pump, *B*, drew oil from the tank through the strainer, *U*, by the pipe, *Z*, and delivered it to the standpipe, *E*. Thence it flowed by the pipe, *I*, to the burners, under a head of about 10 ft. The pump ran constantly, and delivered a surplus which flowed back to the tank through the pipe, *T*. The oil pump was provided with a device, **D*, having a piston connecting by a chain with a cock, *S*, which automatically opened when the boiler was not under steam pressure, so that the standpipe would be emptied of oil by the latter flowing to the storage tank. The steam exhaust of the pump passed through the tank by the pipe, *Z'*, and thence to the atmosphere. By means of this arrangement high cold test oil is kept sufficiently fluid in cold weather to flow freely into the strainer, but it is not sensibly hot to the touch when it arrives at the burner. The pipe, *X*, is a blow-off for draining the burner steam supply pipe, *J*, of water in starting the burner.

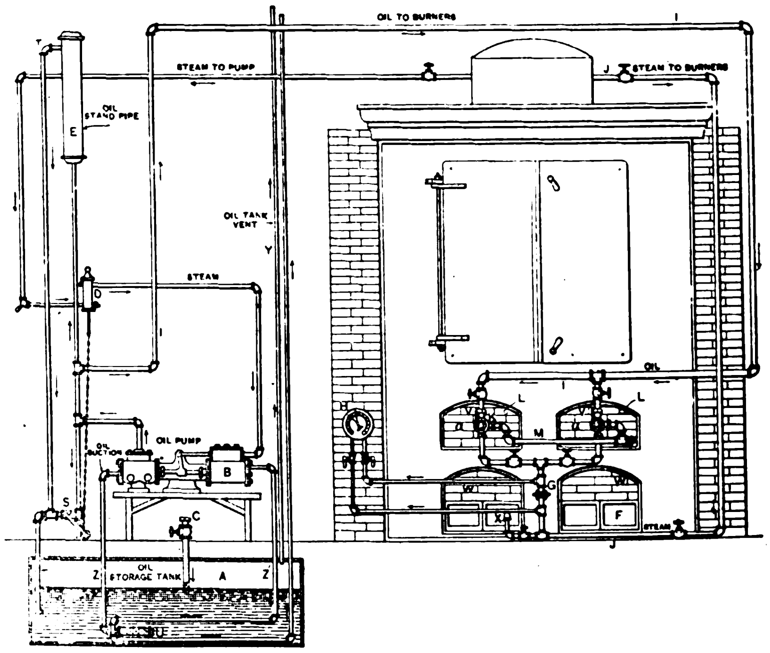

FIG. 1.—DIAGRAM OF FUEL OIL CONNECTIONS.

Air entered the ashpit tiles under the natural draft of the chimney, 70 ft. high by 42 ins. square, connecting to the boiler tested by a 40-in. flue about 30 ft. long.

The oil burner that was used was one that has been patented by Mr. T. H. Williams, under whose supervision the burners were operated during the test. This burner is manufactured by the International Gas & Fuel Company, of Chicago; its construction is clearly shown by Figs. 3 and 4. Oil enters the burner vertically through the opening, *b*, under control of the cock, *c*, the flow being regulated by the handle, *d*. Steam enters through the opening, *e*, and passes through the conical opening, *f*, which is adjusted by means of the hand wheel, *g*. The steam and oil meet where the latter drops between the vertical flanges, *h*. A third opening, *i*, in the burner takes air from the back of the furnace through a firebrick duct built on top of the grate. A mixture of steam, oil and heated air is blown out of the burner and this joins with the main current of air flowing up around the front end of the grate bars and is somewhat heated by its passage along the under side of the grate.

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*This is a safety device required by Western insurance rules.

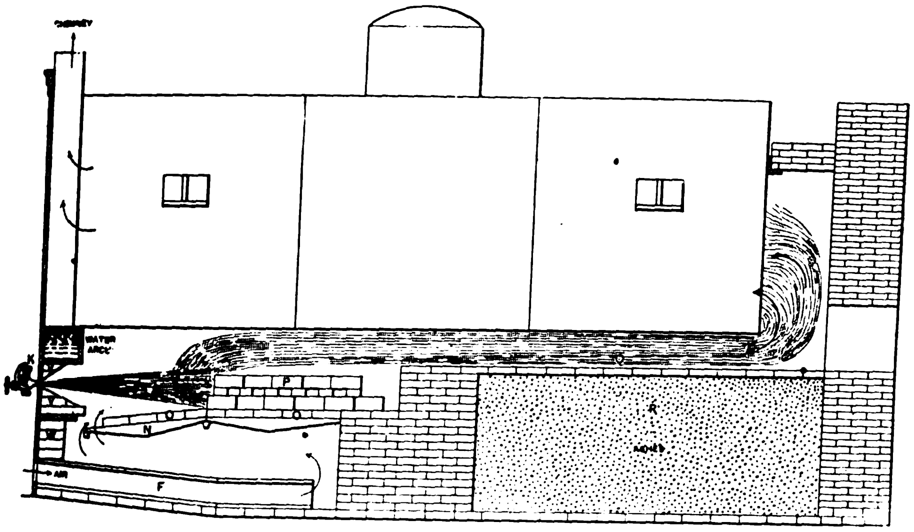
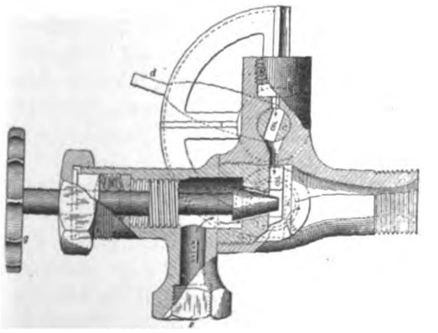


FIG. 2.—LONGITUDINAL SECTION OF FURNACE USING OIL AS FUEL.

In order to measure the steam consumed by the burners the opening in the flange-union, *G*, on the steam pipe, *J*, was reduced to ⅜-in. by a diaphragm, and the pressure each side of this opening measured by the differential steam gauge, *H*. After the tests the readings of the differential gauge were duplicated while the steam flowing was condensed and weighed. The amount of oil consumed was determined by weighing the barrels before emptying them into the storage tank, and by means of a float in the latter operating over a scale which was calibrated for the tests.

The feed water was measured by a reliable meter, which was calibrated at proper intervals. All blow-off connections were properly tested for tightness. The boiler was regularly cleaned internally every ten weeks, and the period of the tests was at the middle of one of these intervals.



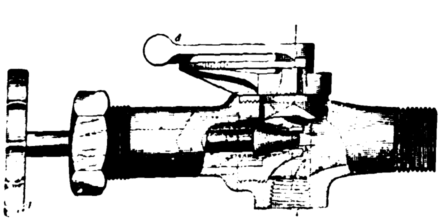


FIG. 3.—SECTIONS THROUGH CENTER OF BURNER.—FIG. 4.

The test began on a Monday night, and from one-half to more than the whole of the boiler horse-power required by the factory was supplied by the tested boiler until the following Saturday night. During this period evaporative tests at various horse-powers were made.

TABLE I.—SUMMARY OF TESTS.

Dimensions of boiler: 6 feet diameter, 18 feet long, 100 tubes 2½ in. diameter, grate surface, 45.5 sq. ft.	Beaumont crude oil used for fuel.					No. 1 buckwheat coal used for fuel.	
Number of test.	1	2	3	4	5	6	7
Duration, hours	3.5	8	11	13	11	12	12
Horse-power	146.9	112.7	189.7	138.0	220.1	92.6	119.1
Steam pressure (gauge) lbs	87	86	86	86	86.5	84.5	86.5
Feed temperature, degrees Fahr	69	90	70	90	74	68	72
Chimney temperature, degrees Fahr	374	360	398	370	425	389	396
Quality of steam	Dry	Dry	Dry	Dry	Dry	Dry	Dry
Moisture in coal	......	......	......	......	......	6.2%	6.2%
Per cent of ash	......	......	......	......	......	16.2%	18.0%
Times fire was cleaned	......	......	......	......	......	Once	Twice
Coal per hour per square foot of grate, lbs	......	......	......	......	......	7.66	10.10
Coal per hour per square foot of heating surface, lbs	......	......	......	......	......	0.182	0.247
Oil per hour per square foot of heating surface, lbs.	0.181	0.135	0.226	0.163	0.263	......	......
Dry steam per hour from and at 212 degrees per sq. ft. of heating surface, lbs	2.73	2.09	3.52	2.56	4.08	1.72	2.21
Heating surface per horse-power, sq. ft	12.6	16.5	9.8	13.5	8.45	20.1	15.6
Total dry steam per lb. of fuel as fired from and at 212 degrees, lbs	15.29	15.53	15.55	15.71	15.49	9.17	8.94
Per cent of steam used by burner*	3.6%	3.1%	4.8%	3.5%	4.8%	......	......
Net lbs. of dry steam per lb. of fuel as fired from and at 212 degrees	14.74	15.05	14.80	15.16	14.75	9.17	8.94

*The steam used by the oil pump was a fraction of one-tenth of one per cent, and it is therefore not considered.

The boiler was allowed to cool from Saturday until the following Wednesday, when the brickwork of the setting was cold, and the water in the boiler at 64° Fahr. The time required to raise 85 lbs. of steam, with the oil fuel, was then determined to be 59 minutes. In a similar test made later, with a coal fire, started with a very liberal amount of dry wood, steam was raised in 1 hour and 17 minutes. After the steam-rising test, the boiler was operated for 24 hours with oil, to use up the 117 barrels provided for the test. It was then cooled, and the oil-burning apparatus removed to prepare the furnace for comparative cool evaporative tests. The boiler and furnace were examined, and no trace was found of any action of the oil on the boiler. There was no oily matter on the internal brickwork, nor any discoloration of the latter, and there was less than one-sixty-fourth of an inch of soot in the tubes, which had been swept clear of coal ashes at the beginning of the use of the oil.

The principal results of the tests are given in Table I.

From these tests Prof. Denton draws the following conclusions:

(1) For a range of from 112 to 220 horse-power the total evaporation from and at 212° per pound of oil varied from 15.71 to 15.29 lbs. of dry steam, and the burner consumption varied from 3.1 to 4.8 per cent of the boiler output, so that the net evaporation ranged from 14.74 to 15.16 lbs. of water per pound of oil.

(2) The combustion of the oil by the burner was practically perfect, since the heat accounted for by the steam production, the hot gases flowing to the chimney, and a reasonable allowance for radiation, represents about 98 per cent of the total heat of combustion of the oil when burned in oxygen in a calorimeter.

(3) The boiler utilized about 78 per cent of the heat of the fuel, which represents the best average boiler practice, and the percentage of steam consumed by the burners is a minimum for steam-jet burners.

(4) An excess of cold air probably caused a loss of evaporation for the smaller horse-powers, but for the 189 and 220 horse-power tests there was no excess of the air necessary for complete combustion. Consequently for the two higher horse-powers the net evaporation of 14.8 lbs. of water per pound of oil may be considered to represent the best economy that is to be expected from the use of the oil as fuel with steam-jet burners.

(5) The evaporation from and at 212° per pound of coal was 9.17 and 8.94 lbs. of water for 93 and 119 horse-power. The

coal showed 11.6 per cent of ash, and 14,680 B. T. U. per pound of combustible when burned in oxygen in a calorimeter, which represents an excellent No. 1 buckwheat. The firemen were the regular employees of the ice company. They were skillful operators, and secured practically complete combustion of the coal, as was shown by the absence of carbonic oxide in the furnace gases, and the fact that the radiation and imperfect combustion item of the "heat balance" was 3.4 per cent. Considering that the coal was laden with 6.2 per cent of moisture, and was consumed in the furnace to about 17 per cent of ash, the evaporative results per pound of wet fuel were excellent. They correspond to an evaporation of 11.79 lbs. from and at 212° per pound of combustible, which affords the very excellent boiler efficiency of 77.6 per cent.

(6) Had the draft been sufficient to burn enough coal per hour to produce about 10 horse-power per square foot of heating surface, as in the case of the 189 horse-power test with the oil—and as is commonly guaranteed in the sale of modern boilers—the boiler efficiency would probably be reduced on account of the greater velocity of the heated gases over the heating surface, resulting in a higher chimney temperature, and hence the waste of a greater proportion of the heat of combustion. Such reduction of efficiency would probably have made the evaporation per pound of wet coal only about 8.5 lbs. But had the percentage of moisture in the coal been the average amount, or 3 per cent, the evaporation would have been about 8.75 lbs.

(7) The comparative fuel costs of coal and oil for the particular conditions of the ice factory where the tests were conducted are therefore as follows:

(A)

For producing the horse-power required by the factory, or one horse-power per about 20 sq. ft. of heating surface, with the moisture and ash as found:

Moisture in coal	6.2%
Ash	16.2%
Weight of oil per gallon	7.66 lbs.
Evaporation per pound of wet coal from and at 212 degrees	9.17 lbs.
Net evaporation per pound of oil from and at 212 degrees	1.51 lbs.
Ratio of oil to coal $\frac{15.1}{9.17}$ =	1.65
Number of barrels of oil equivalent to 2240 lbs. of coal	4.23
Price of coal per 2240-lb. ton, without cartage and cost of ash removal	$3.00
Equivalent price of oil per barrel of 42 U. S. gallons	$0.71

(B)

For producing horse-power upon the commonly guaranteed basis of one horse-power per 10 sq. ft. of heating surface, and with an average percentage of moisture and ash in the coal:

Moisture in coal	3%
Ash	17%
Evaporation per pound of wet coal from and at 212 degrees	8.75 lbs.
Net evaporation per pound of oil from and at 212 degrees	14.8 lbs.
Ratio of oil to coal $\frac{14.8}{8.75}$ =	1.69
Number of barrels of oil equivalent to 2240 lbs. of coal	4.12
Price of coal per 2240-lb. ton, without cartage and cost of ash removal	$3.00
Equivalent price of oil per barrel of 42 U. S. gallons	$0.73

PHYSICAL AND CHEMICAL TESTS OF THE OIL.

Samples of oil were collected from each barrel as it was emptied into the storage tank. A mixture of these was tested in the laboratory to determine the following data:

Specific gravity		0.920	
Flash point		142	deg. Fahr.
Burning point		181	" "
Cold test		—6	" "
Calorific value per pound by oxygen calorimeter		19,060	B. T. U.
Chemical Composition	Carbon	84.60	per cent.
	Hydrogen	10.90	"
	Sulphur	1.63	"
	Nitrogen	0.00	"
	Oxygen	2.87	"

Effect of Sulphur.—The presence of sulphur in the oil gave rise to a strong sulphuretted hydrogen odor from the storage tank. No odor, however, resulted from the combustion of the oil. Excellent Pittsburg coal contains as high as 1.7 per cent of sulphur, and its use affords the average period of the life of boilers. In generating equal horse-power with such coal the amount of sulphur in the furnace gases will be the same with the oil as with this coal, if the sulphur in the oil is as high as 2.6 per cent, which considerably exceeds the proportion of sulphur in the oil. An excellent grade of Indiana coal with 3.5 per cent of sulphur is used on locomotives without being identified with any greater depreciation of the life of fireboxes than occurs with the best Pittsburg coal. The equivalent of the sulphur in this Indiana coal for providing equal horse-power with the oil is 6.9 per cent. In view of these facts there need be no apprehension of shortening the life of boilers by use of the oil. Sulphur in coal in excess of 2 per cent is productive of an excessive amount of clinker, and makes a "dirty" fire, but there is no equivalent of this effect on account of sulphur in the oil.

Economy in handling.—It is probable that one fireman can attend to thirty oil burners of 100 horse-power each. This fact will permit a saving for firing labor in hand-firing plants of more than about 500 horse-power capacity, and in mechanical stoker plants of more than about 1000 horse-power capacity. There would also be a saving in ash handling labor, or helpers in the fireroom, and in cities the cost of carting away ashes would be saved. There would also be a saving in furnace repairs, which may amount to 2 cents per ton of coal. The cost of handling the oil will probably be less for machinery than for coal, but much more for ground space required for underground storage tanks.

Inflammability.—Experiments with samples of the oil used for the evaporative tests show the following results regarding its inflammable qualities: A pool of oil spilled upon a board cannot be ignited by a match; the latter extinguishes itself when partly burned. The instant the match comes in contact with the oil, air is excluded from its lower surface so that the flame is above the oil, and it cannot therefore vaporize sufficient of the latter to bring vapor into contact with the flame of the match and ignite.

A splinter of dry wood, about ¼ in. square and 6 ins. long, ignited at one end, will not ignite oil in a shallow dish, but when this splinter is smeared with oil the latter burns rapidly over the length of the splinter after the end of the latter is ignited to a blaze by a match. The flame at the end of the splinter vaporizes the film of oil near it, so that the vapor floats into contact with the flame and ignites. This vapor in burning vaporizes, and ignites the film farther along the splinter, until the oil over the whole length of the latter is aflame.

A pan 10 x 14 ins., filled with oil to a depth of about an inch, had a handful of blazing waste, saturated with kerosene, thrown into it. The blaze of the waste was extinguished on its lower surface where contact with the oil excluded the air. Hence about forty seconds elapsed before sufficient heat was imparted to the oil by radiation and conduction from the burning waste to vaporize enough oil to cause vapor to rise into contact with the blaze and ignite. Then the burning of this vapor rising from the surface of the oil immediately about the waste vaporized and ignited oil farther away, and thence the whole surface of oil was set blazing. The liquid oil then became heated throughout by conduction, and all of it gradually vaporized and burned. After the pan of oil was once aflame, if it were extinguished by covering the pan, the hot liquid continued to evolve vapor, so that a match thrown on the surface instantly reignited the whole of it.

These experiments serve to show that oil spilled to form a liquid pool, at ordinary temperature about a boiler room, would not be ignited by a lighted match or a hot coal falling into it, and that even a lighted torch would have to be in contact with it for several seconds before it would inflame.

The experiments with the vapor of the oil show that its volatility does not give rise to inflammable vapor until it is heated above 142° Fahr. Then as the vapor is essentially identical with that given off by gasoline at ordinary temperatures, all the well-known safety precautions for the storage and handling of the latter substance apply to the oil, although the rapidity with which vapor is given off per square foot of surface is much less with the oil than with gasoline.

It was suggested during the evaporative tests that the accidental opening of the oil valve of the burner, so as to cause a large excess of oil in proportion to the steam jet supply, might be a source of danger, as it would cause some sort of explosion in the furnace. The maximum draft of the chimney supplied only air enough for the perfect combustion of as much oil as corresponded to about one-half of the full opening of the oil valve. The oil valve of one burner was suddenly changed from this setting to wide open twice on the last day of the use of oil, and the only effect was to fill the furnace with thick smoke, no explosion or excess of pressure in the furnace occuring.

The noise from the fire was equivalent to that resulting from a moderate blowing off of steam from a safety-valve.

Convention of the Northwestern Electrical Association

The tenth annual convention of the Northwestern Electrical Association was held on January 15 and 16 at Hotel Pfister, Milwaukee. The convention was called to order by the president, Mr. E. L. Debell, of Sheboygan, at 12:15 p. m., and after the transaction of some routine business the meeting adjourned until 2 p. m. The afternoon session was opened by an address by President Debell. After referring to the increasing prosperity of the association and the benefits it conferred on its members he said that the work of the Legislative Committee for the past year had been confined to the State of Wisconsin, where very strong efforts were necessary to prevent the enactment of numerous laws adverse to electric lighting interests. These efforts had been entirely successful, and reflected much credit on the committee. He impressed upon all Wisconsin central stations the necessity of greater support and co-operation in this important work. Every company in the state, he said, should share in the necessary expense and work, and also become members of the association, in order to insure complete co-operation and harmony. It had been necessary each year to send representatives to the state capitol to defend their interests, and while the successful results had been enjoyed by all alike the labor and expense attached thereto was borne by only a few.

The president's address was followed by the report of secretary-treasurer T. R. Mercein, in which he submitted the convention programme as part of the report, and touched briefly on the assistance rendered the Legislative Committee by having all bills presented in the legislature which were harmful to electric lighting interests printed and sent free to all central stations in the state, accompanied by a circular urging personal influence with senators and assemblymen to defeat the bills.

The following new members were elected: A. W. Grabe, superintendent Plankinton estate; C. H. Williams, superintendent electrical department, Madison Gas & Electric Company; Beloit Electric Company; Geo. L. Smith, superintendent municipal plant, Harbor Springs, Wis.; Robert D. Crawford, superintendent electric light plant, Castleton, N. D.; Irving Butterworth, general manager Denver Consolidated Gas & Electric Company; A. P. Lathrop, president and general manager, St. Paul Gas Light Company.

Prof. D. C. Jackson, chairman of the Committee on Correspondence Schools, reported that during the past six months he had been too busy to carry on the correspondence which he had started with the correspondence schools. As a result, however, of the action taken by the association in appointing a committee to get the correspondence schools to revise their courses so as to make them more adaptable to central station men, some of the correspondence schools had greatly improved their courses. The result aimed at was, therefore, accomplished, and the association decided that it was unnecessary to continue the committee longer.

The next business was the report of ex-Governor Upham, chairman of the Legislative Committee. He reported having spent five days at Madison during the last legislative session, and that all of the objectionable bills that were introduced were defeated. This list of bills was of the most vicious character, and had the bills passed, the electric light companies of the state would have been mostly annihilated as corporations. Mr. Kountz mentioned one bill that did go through, introduced by an egg man from Sheboygan. This bill was to tell electric light men how to wire houses with No. 14 wire, automatic cut-outs, and a mass of other stuff in which there was no sense. The bill provided a penalty of $25, but no one could tell whom it was against, whether the company or the consumer; but somebody was liable for a fine if they did not put the eggs up in proper shape. (Laughter.)

The first paper presented was one on "Reconstructing and Modernizing Central Stations," by D. M. Rau, of Milwaukee. An abstract is printed elsewhere in this number. In the discussion of the paper, Mr. Rau, in answer to a question by Mr. Gille as to the problem of electric elevator motor service, as related to changing from direct-current to alternating, said that there were several devices on the market for the regulation of the three-phase motor, which accomplish that object very economically; but a controlling device in the form of a magnetic clutch solved the problem. The motor drives through the medium of a magnetic clutch, and as the fields of this clutch are energized it transmits the power at a variable speed to the shaft it drives. He had experimented with this device and found it very satisfactory. Mr. Gille inquired if in the case of a city where they do considerable heating and have a great many small, isolated plants running in the winter and during the summer a large percentage of that business is obtainable by the central station on account of its load being very light, how it was proposed to handle that class of business? In reply Mr. Rau said he did not believe that there was an isolated plant that could exist where there was a properly managed central station. Mr. Gille rejoined that Mr. Rau would agree that an isolated plant of considerable size where they have a great deal of heating to be done, could operate in the winter cheaper than they could buy their current from a central station. Mr. Rau said that in Milwaukee they were from time to time closing down an isolated plant because his station could furnish the power cheaper than they could. A number of plants had been shut down that way very recently, which were very modern. His company is furnishing heat at the same time, which, of course, ought to be considered when a central station undertakes to do that thing.

Mr. Bowen inquired as to the matter of rates, and Mr. Rau said that in the case of the isolated plants he had dealt with so far, he had been able to make a kilowatt-hour rate based on their annual consumption, and that rate was open to anybody else. If a plant had a consumption of $5000 worth of light a year, a certain price was made, and a less price for less light. The ordinary consumer received the regular rate, of course; but the low rate was open to anyone that wanted to get a great amount of current a year, and that consumer paid the same rate as his neighbor who used the same amount. In reply to a question as to whether he would advocate changing over a direct-current underground system to an alternating-current system where there was a large investment in storage battery, Mr. Rau said in his paper he had in mind principally the smaller overhead central stations. When it came to a large proposition, for instance, one like Milwaukee, he did not believe the paper would apply. The alternating current would be generated from very large generators, and there would be direct-current sub-stations.

The question of storage battery auxiliaries coming up later in the discussion, Mr. Rau expressed the opinion that the storage battery was at present out of the reach of small central stations. For cases where it was desirable, or in taking batteries already installed, he would put in a rotary converter set.

The next paper read was by Mr. Van Rensslaer Lansingh, of Chicago, an abstract of which follows:

BEST USE OF ELECTRIC LIGHTS FOR DESIRABLE ILLUMINATION.

Mr. Lansingh pointed out that perhaps no engineering subject of equal importance has in this country received so little attention as the subject of illumination, especially of interiors. While the majority of buildings have, perhaps, sufficient candle-power per square foot, but little attention has been paid to the proper diffusion and distribution of light. After referring to the literature on the subject, and the importance of a steady light, absence of glare and sharp contrasts, he said that the units of artificial lights should in general be distributed as much as possible, at the same time placing them out of the direct line of vision. Curves and figures were given on illumination and diffusion obtained in street lighting with different kinds of globes, attention being directed to the good diffusion with the holophane globe. The diffusion obtained with various kinds of globes most common in incandescent interior lighting was then discussed. In closing the author called attention to the important question of keeping incandescent globes and bulbs clean. From tests made by Messrs. Legg & Townsend, of the Chicago Public Library, it was found that the increase in light, after cleaning the bulbs and shades, varied from 15 to 75 per cent, with an average of 28 per cent.

SECOND DAY'S SESSION.

The Wednesday morning session was opened by the "question-box" part of the programme. The first question put to the convention, and the one which took the entire time assigned to that part of the programme, was that of Mr. Gille, who inquired whether any of the members had had any experience with the Nernst lamp during the past year in a practical way, and if so what were the results? Prof. Jackson, of the University of Wisconsin, reported that he had had some of the lamps in service and that they give a most charming, soft light. The illumination from the Nernst lamp, he said, was of almost the same quality as that from the sun on a summer day when the sky is partly covered with white clouds. No difficulty had been experienced with the lamps in practical operation. No efficiency or life tests had been made, but he had no reason to doubt the figures of the company in regard to them. The lamps in regular operation were six of the two-filament type and three of the three-filament, and they caused no trouble. Prof. Swenson had a single-filament 110-volt lamp in his library at his house for a reading lamp. Those that were in use by the university in the engineering laboratories were all 220-volt lamps. In the lamps a few glower holders had been changed, but there was no difficulty about that whatever. Of the lamps that came to the university every one ran perfectly from the start, without any adjustment whatever or any examination, with the exception of one which, for some reason, did not change over; this was turned over to a wireman, who fixed it, and it has not been heard from since. Prof. Jackson said he had come to the conclusion that so far as the mechanism of the lamps is concerned, they are thoroughly reliable devices; they always start right, and the only question in his mind at all was with respect to their life, though he had no reason to doubt the claims of the company. Replying to a question as to the low-voltage lamps, Prof. Jackson said that the objection he understood the company had to putting out 110-volt lamps was that they were not quite so economical as the 220-volt lamps.

In response to further questions Prof. Jackson said he had had no occasion at all to clean the porcelain of the heaters, as they did not appear to need it. He had examined them recently, and they were clean. This, notwithstanding the fact that they had been desperately overrun (at over 230 volts) and each had consequently burned out a glower.

Mr. Gille said that the only serious trouble he had had was in getting all the glowers started when the lamp was turned on. If a three-glower lamp, for instance, was put up to take the place of an arc light, and only one glower got started, there was a pretty strong kick right off. He had not had the lamps long enough to know what the maintenance charge would be. Four or five glowers had been burned out so far, but they tried to run the lamps at as near 220 volts as possible.

In reply to a question as to the use of the lamps, Prof. Jackson said they were turned on and off a couple of times a day, and burned on an average one hour and a half or two hours a day. The glowers did not always become incandescent at the same time; first one glower would become incandescent and then its heat would bring the other glower into operation. Mr. Gille said that by jarring the lamp slightly, the glowers being seated on spring wires, would jump out of position, and that was probably the reason the glowers do not all start at once. Prof. Jackson said he had noticed that the glowers that sag a little bit very often do not become incandescent immediately, but only after being subjected to the radiation of heat from the working glower. The fact that the illumination was so magnificently satisfactory bespoke a great future for that type of lamp.

Mr. Harding said he had had one of the three-glower lamps in use somewhat over a thousand hours, and three of the single glowers. The trouble of the glowers not starting he had found to be due to evident carelessness in putting the glower in connection with the holder. In one case the leading wire from the glower down to the base and the plug had been sprung or bent. On the three-glower lamp that had been in use somewhat over a thousand hours the glowers were changed once, but instead of changing all the glowers in the holder originally in the lamp, a new holder with glowers complete was put in; these had been in about a hundred hours, and the other one ran fully nine hundred hours without the loss of a glower. An unfavorable point, he thought, was that the glower or holder became black, but by using a paste of a quality that would scrape off readily this difficulty was overcome. He suggested sending out the holders from the central station to the customers and allowing them to make the change; a central station man gathering up the burnt-out holders at reasonable times to put them into shape. He had been more than pleased with the lamp. By substituting for the heavy sand-blast shade sent with the lamp a light alabaster shade, a much better light was obtained for commercial use.

In reply to a question Mr. Harding said he had furnished a customer with a lamp at cost price and maintains the lamp and glower free of charge, which included the replacing of worn-out parts. There was much less expense for each unit of light than with the enclosed arc. Mr. Gille said there were some very delicate parts liable to get broken, and if the building vibrated a great deal there was liable to be trouble. He believed that when many Nernst lamps were put in it should be with the understanding that the customer should pay for the repairs. Mr. Bowen said that in using the Nernst lamp there was a decreased revenue per candle. The question was whether the central stations should furnish the means to their customers for decreasing that revenue or increasing the light for the same revenue, which was the same thing. Gas companies, he contended, did not furnish Welsbachs or other incandescent mantles. Mr. Almert asked the cause for the difference in the life of the glower in operating it on a greater or less number of cycles, the guaranty of the lamp on the life of the glower being eight hundred hours on sixty cycles and twelve hundred hours on one hundred and twenty-five cycles. No one volunteered a reply to the question.

The report of Irving P. Lord, of Waupaca, Wis., as chairman of the committee appointed to consider the advisability of a summer meeting, was then received. The report was to the effect that the sentiment of the members seemed to be largely in favor of a summer convention and outing, with the two words "convention and" in small letters, the place to be Grand View Hotel, Chain o' Lakes, Waupaca, Wis., June 25, 26 and 27, 1902. After a lengthy discussion it was decided to hold the summer meeting as recommended.

Elton J. King, of Fort Wayne, then delivered a paper on "Some Important Points in Commercial Measurement of Electrical Energy," in which he pointed out that the manufacturers, generally speaking, had done much to aid in a satisfactory understanding between customers and central station men by simplifying the readings of dials and reducing the chance of error in computing bills. To the accomplishment of this end some manufacturers were offering counters with larger dial circles and were eliminating constants. In some of the earlier forms of meter the use of constants was avoided on many of the sizes by varying the form of the meter. This method, however, proved unsatisfactory because of the need of a very high speed to avoid constants on large capacity meters. At present the almost universally accepted practice was to design the counter so as to retain the same maximum speed for all capacities of instruments, and to eliminate the constant by changing the gearing of the counter.

The losses due to incorrect registration in many of the large stations reached a percentage of from 10 per cent to 20 per cent after the line corrections had been made, and in many of the smaller stations these percentages were much larger. This discrepancy could be directly attributed, he said, to the slowness in registration of the meters.

Mr. King said that broadly speaking, there were two methods of testing meters in general practice. The practice of testing meters in the shop and substituting them in place of meters about which complaints had been received or concerning which a suspicion of inaccuracy existed on the part of the company was perhaps the most generally used. There were several companies, however, which had competent meter attendants, who checked the calibration of the instruments installed in service. Either of these methods, he said, was fruitful of good results if carefully and intelligently carried out. By carefully inspecting the light load accuracy of the meters a large percentage of the meter loss could be eliminated, and for this reason it was suggested that a more frequent investigation of the accuracy of a light load meter be made. This inspection could be easily and quickly conducted by an inspector provided with a standard lamp, a stop watch and an indicating voltmeter. Provisions could be made for inserting the lamp in circuit where the meter was installed, and it would require but a few minutes to check the calibration of the meter and make any necessary corrections on light loads. This class of inspection could be conducted with good profit at intervals of from four to six months, depending on the conditions under which the meter was installed, followed with a more thorough examination of the meter at intervals of a year and a half or two years. With means at hand for renewing worn out parts, such as the jewel and shaft, the meter attendants should be able to keep the meters in reasonably accurate calibration.

Mr. Gille mentioned the practice of his company of calibrating meters while on the line, using indicating wattmeters, and considered this one of the most convenient ways to check up a meter on the system that he knew of. Mr. King said that calibrating meters with indicating standard wattmeters was really the best and most accurate method of accomplishing results. The use of a standard lamp for checking a light load was convenient for the small central station, as it could be done quickly, but it was advisable to install meters so that they could be checked with a standard wattmeter.

Prof. Jackson was sorry to note the use of a standard lamp and indicating voltmeter recommended for testing meters on light loads, because it was a slovenly method. When the meter expert of a manufacturing company, he said, advised the central station man to use that method, he would use it, and he was sorry to see such advice given. The indicating wattmeter costs no more than the indicating voltmeter, and every central station should have indicating wattmeters for checking its recording meters. If a station could not afford to have a sufficient number of indicating wattmeters to test all sizes of meters under varying loads, it certainly ought to have one that would cover the light loads on all meters, a medium load on the average meter, with perhaps whole load on the average meter. In reply to a question from Mr. Korst as to the practice of checking total output with the amount of current sold, as shown by the meter at the consumer's, and the proportion those amounts are and how they vary with respect to direct and alternating currents, Mr. H. C. Wirt gave some data. In a particular case the kilowatt-hours produced at the switchboard for commercial lighting only were 729,923 by meter, and the kilowatt-hours registered by meter at consumer's lamp installations were 309,001, showing a loss in transmission of 58 per cent and leaving available for sale 42 per cent. Part of this, of course, was line loss, part accounted for by slow meters, and a large part core loss. In another case the figures were 671,006 kilowatt-hours and 393,222.6 kilowatt-hours, respectively, showing a loss in transmission of 41½ per cent, and leaving available for sale 58½ per cent. This latter figure pertained to an eastern station and was probably not any worse than some found in western plants. Mr. Williams said that at the Madison station there were both alternating-current and direct-current meters on the switchboard, and all consumers had meters. The losses were separated, the station taking the core losses, transformer, meter shunt losses, etc., both for the direct and alternating currents.

The alternating-current consumers' meters register from 75 to 80 per cent of the records of the station meters, and on the direct-current and power system from 85 to 90 per cent; the transformer core losses were from 5 to 7 per cent of the output, and the meter shunt losses ran from 3 to 5 per cent on alternating current, which brings the loss unaccounted for down to about 10 per cent.

Prof. Jackson, referring to a remark by Mr. Bowen, said it was not wholly a question of sales per pound of coal that interested the station, but it was the sales per pound of coal plus the cost of labor and interest. When taking that extra item into account it made station wattmeters of more value, because they decidedly influenced the management of the station. Moreover, the station wattmeter, when used properly in conjunction with the monthly readings of the consumer's wattmeter, enabled the station manager to arrive at a point at which he could attack his losses and attack them with the greatest success. But the fact was that more work was done toward improving the steam engine in the station to the last economy, than in all the rest of the plant put together, yet the steam engine was the place where the least amount could be gained ordinarily by the expenditure of a given amount of labor and money. The station wattmeters would go further than anything else towards enforcing the lesson upon the manager's attention that it was not the engine that was at fault, but the firemen, transformers and meters.

Mr. Doherty called attention to the fact that it was necessary to know where the losses came in, in order to correct them. Transformer core losses, he said, are a large part of the total in an alternating-current plant. Mr. Doherty expressed himself a firm believer in the doctrine that an alternating-current station could be made to give more exact regulation than any direct-current station ever built, in transmitting current over any considerable area.

Mr. H. C. Wirt, of the General Electric Company, then read a paper on the subject of "Transformers," which paper he said was the same that was read before the Ohio Electric Light Association, but on the advice of Prof. Jackson he also presented it here.

In acknowledging some complimentary remarks by President Debell, Mr. Henry Doherty pointed out the work that had been and is being done by the National Electric Light Association in the way of getting at reliable figures relating to the operation of municipal electric lighting plants, and the investigation of arc lamp photometry. He bespoke the support of central station men for the association.

THURSDAY.

At the last session of the convention, held Thursday afternoon, the following officers were elected: President, Irving P. Lord, of Waupaca; first vice-president, E. H. Korst, Janesville, Wis.; second vice-president, George D. Westover, Cadillac, Mich.; secretary and treasurer, Thomas R. Mercein, Milwaukee; Board of Directors, F. W. Bowen, of Kenosha; A. M. Barron, of South Bend, Ind.; E. C. Hay, Springfield, Ill.

Prof. Warren S. Johnson and C. S. Fortier, of Milwaukee, then gave a short talk on wireless telegraphy, in which these gentlemen have done much original work.

A HIGH POWER FACTOR SYSTEM OF ARC LIGHTING was the subject of a short paper by W. A. Layman, of St. Louis, which described the constant-current alternating system of arc lighting recently designed by the Wagner Electric Manufacturing Company. After viewing some of the developments that led up to the design of this system Mr. Layman said that the regulation was entirely automatic; the current demand from the dynamo was practically proportional to the lamps burning; and the power factor was high at all loads down to a very few lamps on circuits of from twenty-five to one hundred lamps.

The elements of the system are a constant-potential transformer, the secondary winding of which is divided into sections by taps brought out to contacts on a regulator head; a brush at the end of a pivoted arm adapted to travel over these contacts and moved one way or the other by one of two solenoids, and a relay which puts into circuit one of the solenoids, according to the requirements of the load. The system is illustrated diagrammatically by the accompanying engraving, and was described at some length in a paper by Mr. J. H. Hallberg, read before the Ohio Electric Light Association and reprinted in the November, 1901, issue of this paper.

In response to inquiries as to the power factor and regulation of the system, Mr. Layman said that the full load power factor was 85 per cent with either shunt or differential lamps, and that the regulation varied 0.2 amperes at the outside; the normal variation was 0.15 ampere. The spark at the regulator contacts, he said, is barely visible, as the voltage between steps is about 100 volts. In case of a short-circuit on the line the lever arm moved very quickly, and in addition to that an emergency choke coil was cut in by the relay.

In a paper on "Inspection of Hazards of Modern Plants," H. H. Hornsby, of Chicago, described a long list of examples of construction which had proved defective after a few years' use and had caused fires. A table full of relics was presented with this paper. Most of the paper, owing to the descriptive nature of the matter presented, requires the samples at hand for a clear understanding, so that its publication here would be without interest.

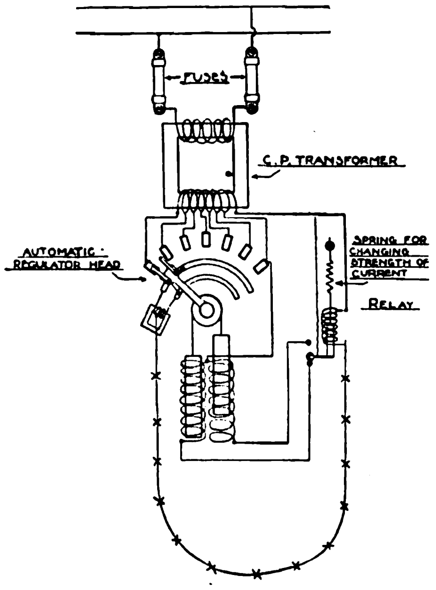


FIG. 1.—AUTOMATIC REGULATOR.

GENERAL DISCUSSION.

At the close of the final session some time was devoted to a general discussion of methods and policy. This was introduced by Mr. Doherty asking (in the interests of the programme for the next National Electric Light Association convention) what matters the members considered of the most importance to the electrical fraternity at this time.

Mr. Gille said he thought that one of the greatest questions before electrical people to-day was the lighting question. A great many engineers had battled with this question a great many years, and it was still in a very primitive state, and he should like to see it taken up and thoroughly discussed, with respect to transmission lines all over the country.

Mr. Grier spoke of the advantage in inducing people to advertise by means of illuminated signs, which was being done to a great extent in large cities.

Replying to a request for a suggestion as to how to get more all-day business, Mr. Wirt said the single-phase alternating-current motor offered one solution. Many central station companies had polyphase machines, and there should be a large field for single-phase motors. Mr. Layman said he knew of a station at Whitehall, Ill., where they had a 90-kilowatt single-phase generator, and during the daytime they operated about 45 horse-power of motors from that. They had one motor of 30 horse-power which was started with a loose pulley, and the countershaft had a good sized fly-wheel on it; by this means they eliminated the fluctuations in the circuit that arose from variations of load on the motor. The motor drove a clay-crushing plant; which was a pretty severe service. Sometimes the load on the crusher was so heavy that the driving belt slipped, but the variation was not sufficient to affect the lighting service that was on the machine at the same time. The same plant operates the city water system, pumping water into a tower at night. When the lighting load is off, a 30-horse-power motor is started a mile away from the station, and a telltale in the water tower indicates when the tower is full; the motor is then cut off at the station. In reply to a question Mr. Layman said that the starting current of a single-phase motor could be regulated through quite a range if one cared to introduce auxiliary devices, as in direct-current motor work. The motor could be started with a succession of steps of increasing voltage, without very largely increasing the current above the full load. It was good practice, he said, with all motors of large size to start them on idle pulleys, and also in small generators to put on a fly-wheel. Small motors were arranged to start without any auxiliary apparatus at all, and in the majority of cases there was no call for it.

In response to a question as to the progress of competition of gasoline Welsbach lights the president said that the report which the committee on that subject presented at the summer meeting did not show any very imminent danger of gasoline lighting taking away any business from electric stations. One member pointed out the very cheap rates that gas companies had made for so-called Welsbach six-burner "arc" lamps. Therewith the point was made by another member that for absolute cheapness nothing could compare with kerosene oil, and that it was the convenience of the electric light, coupled with good service, and not cheapness, that kept electric light companies in business.

The question of isolated plant competition was brought up, especially as to whether lighting of factories that shut down at 6 p. m. was a desirable class of business. President Debell said he believed that the alternating-current station as at present constituted was better off without that class of business, for the reason that they ran only until 6 p. m., or perhaps only until 5:30, and that for only about three winter months and just during the hours of maximum demand. Transformers and motors, etc., had to be kept on hand the year round, and if the shops on any one circuit were of any magnitude, it was necessary to either make that circuit larger to accommodate the transient trade, or else regular customers suffered from poor light during the hours when factories were using that service. While formerly quite a number of such customers were supplied in Sheboygan, they had been let go. All night customers, he said, are the most valuable that an electric station could get, whether the station generates direct or alternating current, and his station had made extremely low rates to get all night lighting business, while 6 o'clock lighting is allowed to go.

Mr. Harding said he had had an entirely different experience with 6 o'clock business. His town, he said, was small, and a big proportion of the business in lighting was for residence purposes. Taking the load curve for say, December, the load peak usually occurred very close to 4 o'clock; often it was much earlier than that, but taking the average for the month it would probably run to 4 o'clock. The factories all ran on sun time, which is 15 minutes ahead of standard time, and he found that the peak of the load came on long before the hours of residence lighting, and remained without any increase during the hours that the factories began to shut down and the residence load began to come on. The factory business had thus been very profitable. If only all night business were procured he might not find the factory business so profitable, but in making a rate for 6 o'clock business he incidentally stumbled on some 600 or 800 incandescent all-day lights—business that never existed before. As the station was also in the heating business, it wanted the day lamps and not the night lamps; it had already enough of the latter. In reply to a question Mr. Harding said that about 80 per cent of his business was on meter, and all new business was on meter rates, and that the peak of his load was due to heavy factory work. There are two large woolen mills and some five or six other fair-sized factories on the circuits that use from 150 to 500 or 600 lights, and these are all on by 3 or 4 o'clock; very little of the residence lighting is on at that time, which accounts for the fact that the peak load remains uniform as long as it does.

President Debell said it was necessary to consider the total load on the electric as well as on the steam machinery, because that was what had to be provided for. The capacity for supplying factories running up to 6 o'clock for a period of 2 or 3 months in a year had to be cared for not alone by electric machinery, but by steam plant. Generally speaking, he said where a station had to maintain a considerable capacity both in its steam and electric plant and in the circuits on which those factories were connected, including transformers, etc., for the time that service was required by such customers—say not to exceed three months in the year or thereabouts—such business was not profitable at the ordinary rates; while on the other hand, the all-;ht customers constitute really the st valuable business that a station could get. Mr. Harding reminded Mr. Debell that he ran a twenty-four hour service, which was due primarily to the heating plant; and that he had been able to connect up a factory lamp for practically every residence lamp put on the service circuit, because there were enough of the factory lights not turned on to offset the few that came on early in the residences.

The committees appointed for the coming year were as follows:

Committee on Uniformity in Advertising Pamphlets—H. J. Gille, St. Paul; F. W. Bowen, of Kenosha, and A. M. Barron, of Franklin, Ind.

Committee on Legislation—Mr. L. B. Livermore, Winona, Minn., chairman of the committee. The first of the following names from each state will be the chairman of the committee in that state: For Illinois, C. E. Hay, Springfield; W. H. Schott, Chicago; E. P. Maxwell, Dixon. For Michigan, W. Worth Bean, of St. Joseph; W. F. Kingan, Sault Sainte Marie; E. D. Daniell, Menominee. For Wisconsin, H. C. Higgins, Marinette; T. F. Grover, Fond du Lac; C. H. Williams, Madison. For Minnesota, S. B. Livermore, Winona; H. J. Gille, St. Paul; Prof. G. D. Shepardson, Minneapolis. For Indiana, J. H. Harding, Laporte; A. M. Barron, South Bend; H. W. Frund, Vincennes. For Iowa, M. J. Green, Cedar Rapids; C. C. Hammond, Mason City; J. A. Innes, Eagle Grove.

The following central station men were in attendance: J. S. Allen, Beloit, Wis.; A. M. Barron, Franklin, Ind.; F. W. Bowen, Kenosha, Wis.; W. P. Bragg, Monroe, Wis.; Irvin Butterworth, Denver, Colo.; T. P. Carrier, Edgerton, Wis.; W. F. Collins, Wausau, Wis.; E. L. Debell, Sheboygan, Wis.; H. L. Doherty, Denver, Colo.; C. F. Freehauf, Cresco, Iowa; H. J. Gille, St. Paul, Minn.; W. J. Greene, Cedar Rapids, Iowa; A. J. Hamacek, Sturgeon Bay, Wis.; J. H. Harding, Laporte, Ind.; H. C. Higgins, Marinette, Wis.; P. H. Korst, Janesville, Wis.; George H. Kuelthan, West Baden, Wis.; A. Kuhlman, Elkhart, Ind.; A. P. Lathrop, St. Paul, Minn.; Irving P. Lord, Waupaca, Wis.; Sinclair Mainland, Green Bay, Wis.; M. E. Malone, Madison, Wis.; H. F. Pearce, Negaunee, Mich.; O. M. Rau, Milwaukee, Wis.; W. W. Rod, Appleton, Wis.; F. G. Rodolph, Mascoda, Wis.; W. H. Schott, Chicago and Bloomington, Ind.; Geo. L. Smith, Harbor Springs, Wis.; G. H. Strang, Richland, Wis.; R. Trumbull, Kenosha, Wis.; W. H. Upham, Marshfield, Wis.; Bradford D. Viles, Chippewa Falls, Wis.; M. Weeks, Wausau, Wis.; Geo. B. Wheeler, Eau Claire, Wis.; C. H. Williams, Madison, Wis.; O. B. Williams, Whitewater, Wis.; and G. E. York, Portage, Wis.

Abstracts from Foreign Contemporaries

Lifting Jack for Electric Cars.—*Engineering* describes a lifting jack designed especially for electric car purposes and now being used on many of the English railways. The arrangement is well shown by Fig. 1, from which it will be seen that by the combination of a toggle joint and a right and left-hand screw worked by a ratchet lever, very great power is obtained in an apparatus of compact form and moderate weight. The steel baseplate is 20 ins. long and 8 ins. wide, while the total height over all is 6½ ins., and the complete weight is 96 lbs. The movement is vertical and the motion, when the jack is loaded, is regular and well under control. It has been found to be admirably adapted for changing axle brasses on the road, for lifting trucks to remove broken clipper-brake parts, etc. In one case of a broken axle it was found to be the best appliance for enabling a repair to be executed, as the jack gave a direct lift, and every inch lifted was a clear gain.

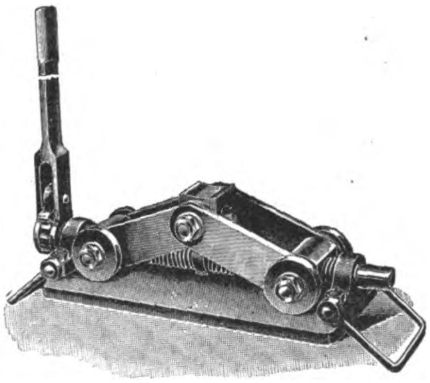


FIG. 1.—LIFTING JACK.

Sinclair Water-Tube Boiler.—A new water-tube boiler, somewhat radical in design, has been devised by a Mr. George Sinclair, and was recently described in London *Engineering*. The arrangement of the boiler is clearly shown by Fig. 2. One of the chief features is the angle at which the tubes are set, so as to afford something equivalent to a combustion chamber. The front and back headers are common to all tubes and are not divided to form elements. They are built with a bend at the center, as shown; while the front header is 7½ ft. from top to bottom, the back header is 11 ft. and a space of 3½ ft. separates the upper and lower nests of tubes at the rear. Divisions are provided, as shown in the longitudinal section, to guide the gases so as to secure the fullest measure of heat utilization. The water circulation is down the back header, through the tubes, the steam passing up the front header and through a series of riser tubes into the drum, while the unevaporated water tends to pass through the upper series of nearly horizontal tubes. The boiler is constructed of steel, with the exception of the tubes, which are of charcoal iron, and is designed for a pressure of 400 lbs. to the

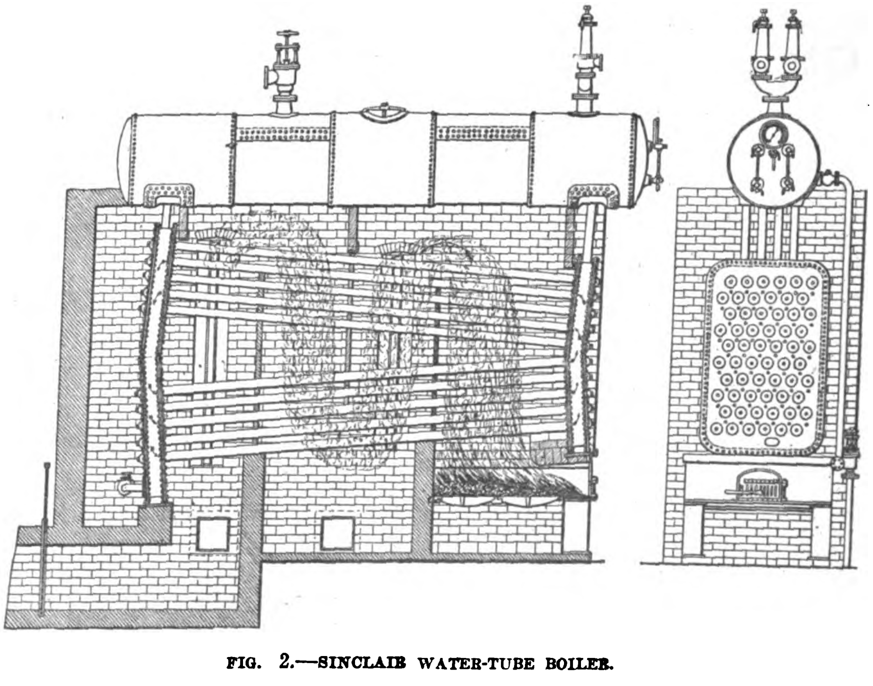


FIG. 2.—SINCLAIR WATER-TUBE BOILER.

square inch. The tubes are 16 ft. long and 4 ins. in internal diameter, and the distance between the front plate and the rear plate of the headers is 17½ ft. The drum is 21 ft. long and 3½ ft. in internal diameter, and the distance from the bottom of the front header to the top of the drum is 13 ft. 2 ins. The total length of the boiler from the stoking floor is 21½ ft. and the clear width is 7 ft. 4 ins.

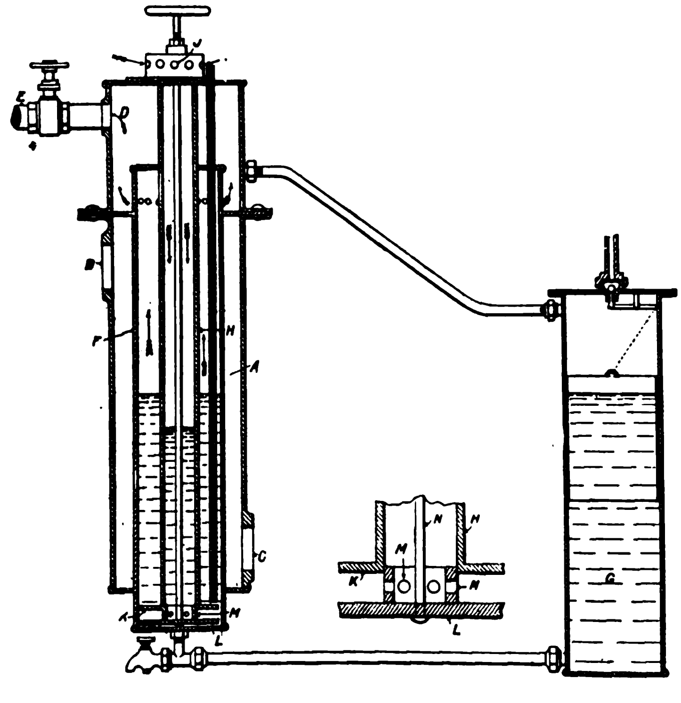


FIG. 3.—MOORWOOD-BENNETT CARBURETOR.

New Oil Gas Generator.—Fig. 3, herewith, shows the general arrangement of the Moorwood-Bennet carburetor for use in conjunction with ordinary oil or gas engines, and utilizing oils having high flashing points. The apparatus has recently been introduced in England and is described in the London *Engineer*. It consists of a closed cylindrical vessel, the lower part of which, *A*, has two openings, *B* and *C*, one connecting with the exhaust from the cylinder of the engine, and the other to the atmosphere. The upper part, *D*, of this vessel connects with the engine cylinder through a pipe, *E*. There are two concentric cylinders inside the cylinder, *A*, the larger of the two, *F*, being in communication with an oil reservoir, *G*. This cylinder is provided with holes at its upper end, as shown; the innermost cylinder, *H*, is open to the atmosphere, through the perforations shown at *J*. The lower end, which descends to nearly the bottom of the cylinder, *F*, is shown somewhat enlarged in the figure at the side. It is furnished with a flange or disk, *K*, and inside it is a sliding tube having perforations, *M*, and a flange, *L*, at the bottom. The distance this tube slides into *H* is regulated by the spindle, *N*, which has a screw and hand wheel at the top. The action of the apparatus is as follows: On account of the vacuum in the engine cylinder air enters the holes, *J*, passes through the oil in *H* and the holes at *M*, whence it rises through the oil in *F* and finds its way, highly charged with oil vapor, to the cylinder. The exhaust gases being led into the jacket, *A*, the oil is heated, with the result that the drawing of air through it produces a vapor which may be employed in an engine with excellent results. A feature claimed for the apparatus is that practically all the by-products in the oil are prevented from entering the cylinder, and only the constituents which will be wholly converted into gas on combustion pass through.

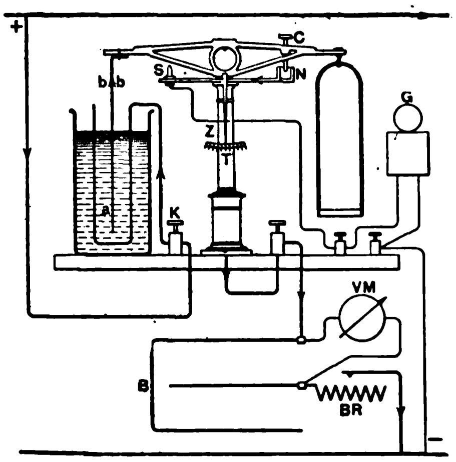


FIG. 4.—COPPER VOLTAMETER BALANCE.

Automatic Copper Voltameter Balance.—The *Zeitschrift fuer Elektrochemie* describes an improved apparatus for automatically determining the weight of metal deposited in a certain time in an electrolytic bath. Heretofore in electroplating work it was necessary to remove the cathode and carefully wash and dry it before the actual gain in weight could be ascertained. The improved balance designed by W. Pfauhauser and shown diagrammatically by Fig. 4, permits the cathode to be weighed without removing it from the solution. In the diagram, *a* is the depositing cell and *B* the plating bath, which is in the same circuit. The pillar of the balance acts as one portion of the circuit, the current passing through the apparatus as indicated by the arrows. When the weight of the metal deposited reaches a certain value the left end of the beam drops, making electrical connection with the bell, *G*, through the contact, *S*, causing the former to ring. At the same time the contact between the mercury cup, *N*, and the point, *C*, is broken and the main circuit is switched out and the plating ceases. The balance has been specially designed for use in connection with silver-plating work. The principle of the device is by no means new, as Edison patented a self-registering voltameter somewhat similar in principle and design as far back as 1880.

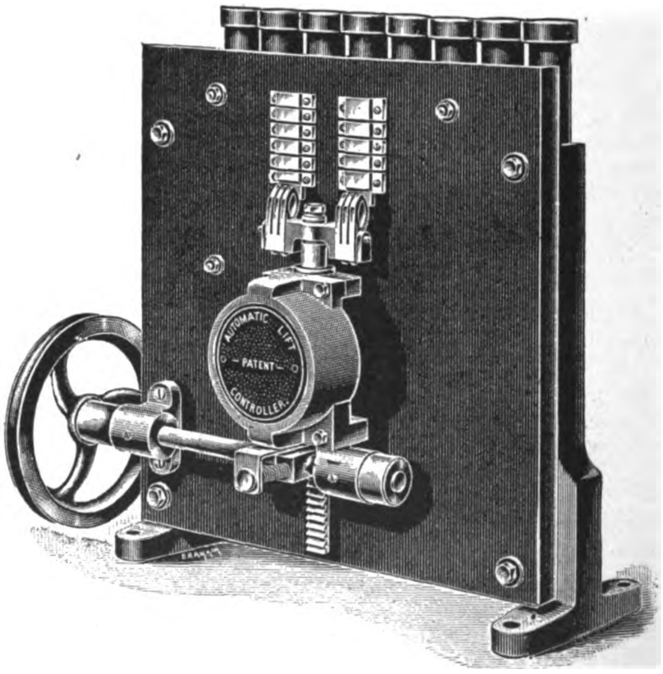


FIG. 5.—ELECTRIC ELEVATOR CONTROLLER.

Automatic Electric Elevator Controller.—The accompanying illustration, taken from the *Electrical Times*, shows a reversible automatic elevator or dumb waiter controller, which eliminates the hand rheostat and performs its functions without the aid of the usual actuating magnets and dashpots; the required slow motion being obtained direct from the motor shaft, worm gear or winding drum of the elevator. The apparatus is fireproof, strongly made and compact, and is said to give a starting acceleration free from jerks. The starting resistance is independent of the control of the operator and cannot be cut out unless the motor starts, the rate at which it is cut out depending on the speed of the motor in starting. The armature, therefore, is in no risk of an excessive current rush, nor can the motor be forced to start if overloaded. Should the current fail from any cause, the resistance is instantly inserted in the armature circuit. The reversing switch is arranged to open the circuit at several points instantaneously, thereby avoiding destructive sparking. Reversal of current is effected by a half-turn of the sprocket wheel of the reversing switch, which can be adapted by means of a chain connection to any of the mechanisms in use.

New Form of Diaphragm Cell.—J. B. C. Kershaw describes in a recent issue of the London *Electrician* a new form of diaphragm cell for the electrolytic production of alkalies and chlorine. Sectional end and side elevations of this cell, which is known as the Moore-Allen, are shown in Figs. 6 and 7. The cell consists of two end walls, *a a*, rabbetted at their upper ends to receive two side bars, a^1 a^1, thus leaving the lower part of the sides of the cell open. The ends are secured to the bottom plate, a^2, and ends, side bars, and bottom are made preferably of slate. The open sides of the cell are closed by a diaphragm, *b*, of asbestos or some material that will permit free percolation of the electrolyte. On the outside of each diaphragm is the cathode, *c*, consisting of several layers of wire cloth, or of a bed of steel wool sufficiently thick to hold the solution by capillary action. The diaphragm and cathode are bent under the bottom plate, a^2, and the cathode in this manner makes electrical contact with the iron tray, *d*, in which a number of cells stand. This tray serves two purposes—it acts as a negative conductor for all of the cells standing upon it, and it collects the sodium of potassium hydrate solution dripping from the cathodes. The top of the cell, *f*, is of lead. The anode consists of a number of blocks of gas carbon, *e e*, cast into a lead plate, e^1. The chlorine gas liberated at the anode is conducted away through the glass dome, *g*, and the lead pipe, g^1. The supply of brine to the cells takes place through the pipe a^3, inserted in the wall, and provision for keeping the electrolyte saturated is made by the use of a funnel, *p*, at *h*. The iron plate, *d*, is provided with a channel along one side, and the solution of sodium or potassium hydrate flowing from a large number of cells is collected by setting the plate on which they stand in a slightly inclined position. The advantages claimed for the cell are that no steam is required to remove the hydrates from the cathode, that a fairly concentrated solution is obtained containing little undecomposed salt, and that the design and structure of the cell are simplified by dispensing with an enclosed cathode compartment. The use of the glass dome on the chlorine exit of the cell is said to facilitate the technical oversight of the process, and to lessen the dangers arising from electrical short circuits by the lead of the chlorine collecting pipes.

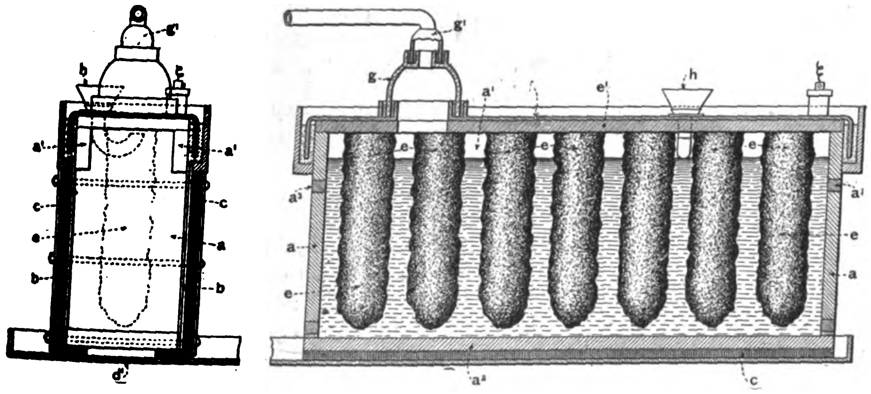


FIG. 6.—MOORE-ALLEN DIAPHRAGM CELL.—FIG. 7.

Multiple Distributing Box.—The ingenious device shown by Fig. 8, which was taken from the London *Electrical Review*, was designed to form a compact, simple and neat distributing box for use where several circuits have to be taken off for various purposes. The box is of porcelain, the metal receptacle tubes radiating from its centers, as shown in the illustration, and each being well separated from the others. The maximum number of circuits which can be plugged in is six. The plugs used are of the "Dot" gauge and have provisions for cord grip without increase of size. Fitted with a fiber disk and contact pins, it forms a convenient distributing center for a floor connection.

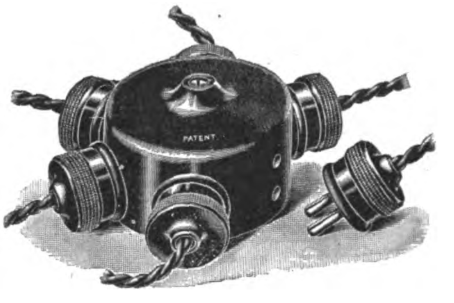


FIG. 8.—TURRET DISTRIBUTING BOX.

New Meter for Direct Currents.—Fig. 9, herewith, shows a new meter for measuring direct currents which presents several points of interest, and which was recently described in the London *Electrical Review*. The instrument is very similar to the Halsey type of meter made in this country. The moving member consists of a cylindrical copper armature, *A*, rotating upon a vertical spindle, *B*, which is supported on a jewel bearing, *C*, and is held in place by a spring bearing, *D*; the armature rotates in an annular chamber, *H*, formed partly by the poles of the meter and partly by an antimony block, *T*, which chamber is filled with mercury to a height shown by a gauge glass in the front. An intense magnetic field is produced between the pole pieces, *K*, *L*, by a permanent magnet, *M*. The current to be metered enters the lower part of the chamber by the conductor, *F*, and passes up the armature between the pole-pieces to the conductor, *G*, causing the armature to revolve. The brake force of the meter is provided by the Foucault currents induced in the revolving armature. The armature is plated with platinum at the points where the current enters and leaves it, to protect it from the action of the mercury. The chamber is closed at the top by an ebonite cover, *P*, through which the spindle passes. The latter is provided with balance weights, *Q* and *R*, adjusted so that the armature practically floats in the mercury, the pressure on the pivot being very slight. By means of a lifting device, *S*, the armature can be lifted so as to relieve the jewel bearing, and to prevent it from being injured during transit; and at the same time the mercury chamber is sealed by the pressure of the balance weight, *Q*, against a rubber washer, *W*, inside the cover. The upper balance weight, *R*, carries a steel pin, *X*, which engages the first wheel, *Y*, of the integrating train and advances it one tooth for each revolution of the armature. The mechanism is enclosed in a cast-iron box from which it is insulated by ebony blocks, *Z*. In order to increase the accuracy of the instrument the current passes round a coil wound upon an iron core, *V*, which is so arranged as to weaken the magnetic field when the current is strong, and to reduce the braking force relative to the driving force. It is worthy of note that this object is obtained not by weakening the flux through the permanent magnet, but by diverting part of it from the pole pieces and armature; thus an excessive current does not tend to weaken the magnet. The drop in the meter is said not to exceed 0.4 volt at full load, while the armature revolves with 0.05 ampere.

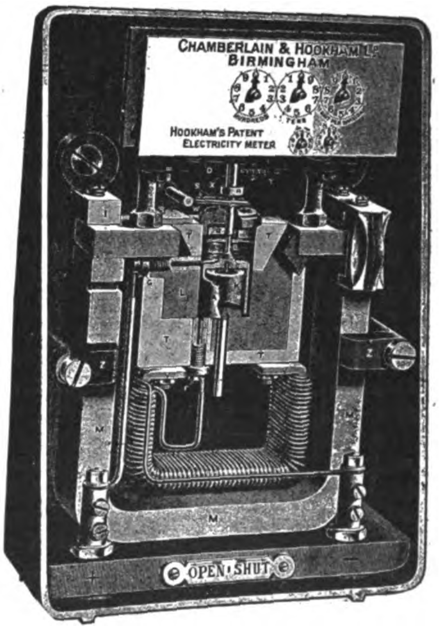


FIG. 9.—DIRECT-CURRENT METER.

Electric Testing Keys.—A discharge key, which, according to the London *Lightning*, may be used in measuring electrostatic charges of a cable or condenser, and can serve generally as a highly insulated two-way switch, is shown in Fig. 10. Spiral wire connectors are used in order to ensure perfect metallic connection between the contact arms and their terminals, and the bearings can therefore be well lubricated so as to secure free movement. The rubbing contact surfaces are of gold and platinum respectively, kept clean and bright by the friction. Fig. 11 shows the handles in the position for charging the cable or condenser. When the shorter handle is moved to the position indicated by the dotted line, the cable or condenser is free from the "loss-of-charge" test, and the leakage over the apparatus is restricted to its insulating support. The switching over of the long handle pushes the short handle over also, if it be not already over, and so breaks the battery contact and discharges the condenser or cable through the galvanometer. Fig. 12 shows the usual arrangement in the testing room, two keys being used to allow both capacity and insulation tests to be made without changing the key connections. In the diagram the handles are shown in their normal positions. For the capacity test both handles of K_1 are put over to the right for charging, and to the left for discharging. For insulation tests both handles of K_2 are put over to the left for insulation readings and to the right for earth readings.

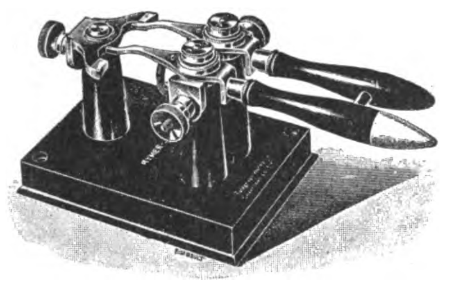


FIG. 10.—TESTING KEYS.

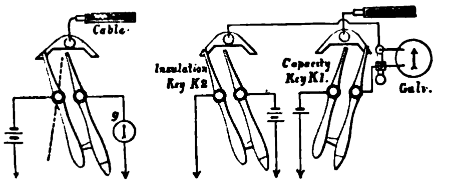


FIG. 11.—TESTING KEYS.—FIG. 12.

Rotary Engine.—A curious form of American rotary engine—known as the Verett engine—is now being introduced in England, according to the London *Engineer*. The machine is made in sizes from 1 to 10 horse-power, forms its own fly-wheel, and takes steam through the hollow shaft. Around the shaft are four cylinders, at right angles to one another, with their heads outward, and their bases connected to the shaft. Attached to each cylinder head are two slide bars, the ends of which are attached to the rim of the wheel, and thus form the spokes. There are two high-pressure and two low-pressure cylinders. The crossheads of each tandem pair of cylinders are connected by yokes or frames which embrace the shaft and are fitted to eccentrics on the shafts, the position of which can be varied or adjusted. The longitudinal movement of each yoke, with a reciprocating motion, serves to swing the yokes around the eccentric, carrying the cylinders and shaft with them. As the two yokes operate alternately and give an impulse at each stroke, there is a constant turning movement without any dead center. The position of the eccentrics in relation to the steam chest chambers and cylinders is such that the yokes will be in proper position to swing around the eccentrics upon receiving a stroke from the pistons, whose crossheads they connect. The central portion of the shaft is enlarged and formed with steam passages, the enlarged part being conical at each end to receive the steam chests, which are supported by arms adjustably attached to the frame. Each steam chest is formed with a partition forming a steam chamber, exhaust chamber, and an intermediate chamber; communication between the steam and intermediate chambers being furnished by a valve. The steam supply chamber only communicates with the ports which lead to the high-pressure cylinders when the valve is closed. These cylinders exhaust into the intermediate chambers; the steam then passes to the low-pressure cylinders and then to the exhaust chamber. [The foregoing description appears to fit the Vezin engine built in this country. —Ed.]

Some Recent Electrical Patents

Limiting Device for Incandescent Lighting Circuits.—In electric lighting plants where current is furnished to consumers under an arrangement which contemplates limiting a consumer to the use of less than the total number of lamps installed on his premises, some means is usually adopted for arbitrarily preventing the consumer from turning on more lamps than his contract limit provides for. Various appliances of this sort have been devised, among them being an inaccessible limit switch, which opens the circuit when the predetermined number of lamps has been exceeded. This arrangement has found objection from the fact that all the lamps on the premises would be extinguished in the event of the consumer inadvertently turning on more lights than he was entitled to burn, and the premises would be in darkness until an employee of the lighting company could reach the spot and restore the circuit. As a less objectionable check, devices have been brought out which, instead of cutting off the supply entirely, insert resistance in the circuit, so as to dim the lights. An arrangement which appears to be a more moderate reminder than either of these two has been patented by Ralph J. Patterson, and is illustrated by Fig. 1, herewith. This consists of two magnets, *M* and M^1, each of which is connected in series with a carbon break, the two circuits being in parallel between the terminals, 14 and 14. The device is connected in series with one leg of the consumer's circuit, and its operation is as follows: So long as the current remains below the predetermined limit the circuit will be as shown in the diagram, the current passing through the magnet, *M*, the contacts, 109 and 110, and out at the right-hand terminal, 14. Should the current exceed the proper limit, the magnet, *M*, closes the carbon contacts, 5 and 6, allowing current to pass through the auxiliary magnet, M^1, which immediately opens the contacts, 109 and 110. This deenergizes the magnet, *M*, and the carbon contacts 5 and 6 are again separated by the spring and weight on the lever connected to the upper contact. When these contacts separate, the full current is passing through them, and an arc is drawn, introducing considerable resistance into the circuit, and dimming the incandescent lamps. This arc being in series with the magnet, M^1, the reduction in current weakens that magnet sufficiently to allow the weight, 115, to close the contacts 109 and 110, again energizing the magnet, *M*. The carbon contacts, 5 and 6, are thereby brought together, extinguishing the arc, and the cycle is repeated, causing a flickering in the incandescent lamps so long as the current is beyond the normal point. Patent No. 689,830.

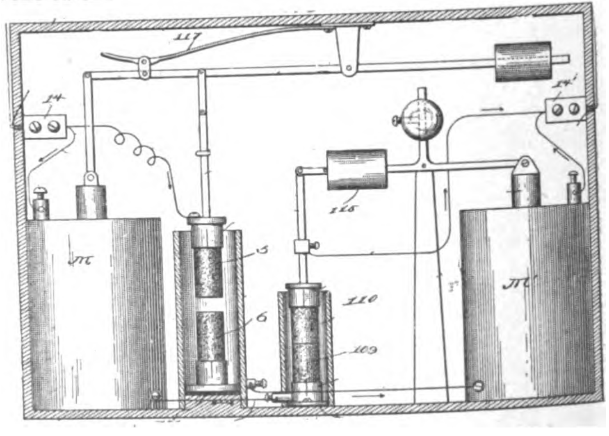


FIG. 1.—CURRENT-VARYING DEVICE FOR ELECTRIC CIRCUITS.

Sewing Machine Motor.—A rather ingenious application of the well-known friction disc method of transmitting small powers has been made by Harold R. Wellman to electric motors for driving sewing machines. The accompanying engravings show the arrangement very clearly. The motor, 8, is mounted between the arms of a bifurcated rocking lever pivoted at 12 and connected to the treadle so that the sewing machine operator can tilt the motor in either direction at will. The spindle of the motor carries a friction disc, 10, which is pressed against the rim of the sewing machine wheel. It is obvious that when the center of the friction disc is against the rim of the sewing machine wheel no motion will be imparted to the sewing machine, and that tilting the motor to one side will enable the disc to transmit motion to the sewing machine wheel. The ratio of speeds depends upon the distance from the center of the disc to the point at which the sewing machine wheel touches the disc. Patent No, 690,-334.

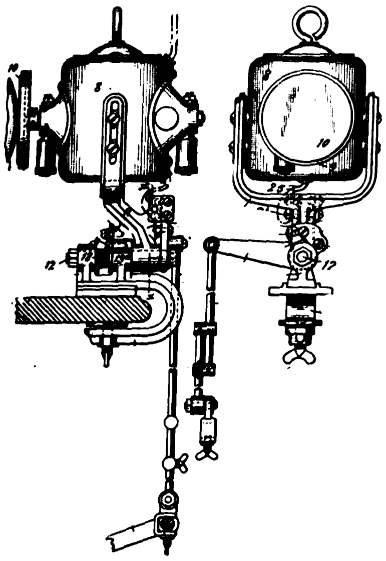


FIG. 2.—SEWING MACHINE MOTOR.

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NOTES.

Wireless Telegraphy in Arctic Regions.—A press dispatch from Copenhagen, Denmark, states that Iceland, Greenland, the Faroe and the Shetland Islands, and the Dominion of Canada, may soon be in communication with each other by means of the Marconi system of wireless telegraphy.

A Banquet to Telephone Men.—It is announced that on or about April 9, when the Illinois Independent Telephone Association is to convene in Chicago, a banquet will be tendered by the local manufacturers and dealers in telephone apparatus to telephone exchange representatives from Illinois and adjoining states. It is stated also that a movement is on foot for the establishment of a central states' telephone association, and that this matter will be discussed at the coming convention.

Gas Engine Castings and Forgings.—Readers who were interested in the design for a 1-h.p. gas engine which appeared in the December, 1901, issue of this paper will doubtless be glad to know that complete sets of brass and iron castings and steel forgings can be obtained from Mr. J. C. Brocksmith, the designer of the engine. Mr. Brocksmith's address is 488 Douglas Boulevard, Chicago, Ill.

Electricity for the New York Central.—According to the *New York Times*, the officials of the New York Central & Hudson River Railroad Company have made tentative plans for the equipment of the suburban local service with some system of electric traction. The details of the proposed equipment are not given, but it is intimated that all of the suburban trains will be hauled electrically, while the through main-line trains will continue to be drawn by steam locomotives within the city limits as well as outside.

Castings for a Small Dynamo.—We are glad to announce to the many readers who have from time to time made inquiries for such material that complete castings for the 1-h.p. motor or dynamo described in our issues of December, 1898, and January, 1899, can be obtained from Mr. Floyd S. Flickinger, Council Bluffs, Iowa. Mr. Flickinger has built the machine, and having the patterns on hand has kindly offered to assist other amateur builders, who have not the facilities for making the patterns, by supplying them with castings.

Tesla's Wireless Telegraphy.—according to an interview with Mr. Tesla, as published recently by the *New York Sun*, concerning his wireless telegraph system, the inventor said: "I respect rigorously the rights of others, and when (*sic*) I give my system to the world I shall ask the entire technical profession to point to any feature of my system—the transmitter, the receiver, the means and methods of recording, the means and methods of producing the requisite electrical energy, and the means and methods of securing absolute privacy and non-interference—which is not of my own creation." Echo answers, "when?"

Hearing on the Metric System.—Representative Southard, of Ohio, chairman of the House Committee on Coinage, is reported to be sending invitations to a number of the chief manufacturers, merchants and other engaged in mercantile pursuits, to appear before the Coinage Committee on February 6 at the hearing on the bill for the adoption of the metric system of weights and measures. Congress has already secured the views of scientific men on this subject, but Mr. Southard holds that such a change in the entire system of weights and measures is a practical question, on which the large business interests should be heard. Among those said to be invited are vice-president W. M. McFarland, of the Westinghouse Electric & Manufacturing Company, and Superintendent Vauclain, of the Baldwin Locomotive Works, as well as the electrical experts of several large concerns, and the officers of a number of large woolen and textile industries.

Telephone Installation on the Illinois Central.—The Illinois Central Railroad is to make extensive use of the telephone, beginning at principal points on the line, such as Chicago, St. Louis, Louisville, Memphis and New Orleans. The work of installing a two-wire copper telephone circuit will begin within a short time, and these lines will be gradually extended to cover the whole system. The object immediately in view is to establish telephone communication between the principal terminal points on the road and division headquarters. The first use to which the line will be put will be the transmission of the ordinary messages of the traffic and other departments, but the service will be gradually expanded to include all messages of both the business and operating departments.

Marconi Entertained by the American Institute of Electrical Engineers.—On January 13 the American Institute of Electrical Engineers gave an elaborate dinner at the Waldorf-Astoria Hotel in honor of Mr. Guglielmo Marconi, the dinner being attended by over 300 members of the Institute and a large number of ladies. The guests included a number of notables, among whom were Prof. Elihu Thomson, Prof. Alexander Graham Bell, Sir Percy Sanderson, British Consul General; Cav. Branchi, Italian Consul General; Institute Past President Carl Hering, Messrs. Frank J. Sprague, William Stanley and E. W. Rice, Jr., and Professors F. B. Crocker and M. I. Pupin, of Columbia University. President Steinmetz made a short speech after the dinner was over, in which he extended a cordial welcome to Mr. Marconi, and then turned the conduct of affairs over to the toast-master, Mr. T. C. Martin. The feature of the occasion was a notably modest talk by Mr. Marconi, in which he gave a brief summary of what has thus far been accomplished in wireless telegraphy, and an interesting description of his recent experiments in the direction of transatlantic signalling. Mr. Marconi gave generous credit to the pioneers in the investigation of electrical waves, saying that his own work had been built largely on the work previously done by James Clerk Maxwell, Lord Kelvin, and Professors Henry and Hertz. Prof. Elihu Thomson then paid a glowing tribute to Marconi for the great ability which he had shown in building up his system, and pointed out that the fact that the system was founded upon fundamental principles discovered by others detracted not in the slightest degree from the merit of Marconi's work, which had placed him among the first inventors of the world. Prof. Pupin also paid tribute to Mr. Marconi's work, and showed the lack of foundation for some criticisms that had been made concerning it. He followed these remarks by giving quite a lengthy exposition of the principles of wireless telegraphy, and said that the theory he outlined satisfies the criterion laid down by Heaviside and explains very satisfactorily the Marconi system.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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Reconstructing Central Stations.

The brief paper read by Mr. O. M. Rau before the convention of the Northwestern Electrical Association last month, an abstract of which appears elsewhere in this number, contained a great deal of sensible advice which managers and owners of moderate-sized plants will do well to follow. Mr. Rau's argument as to discarding old equipment for modern types is conservative in many respects, and no argument can be sounder than a conservative one. Concerning the present status of electric generating apparatus, however, the statement that "the highest development has by no means yet been obtained" is a little misleading by its very conservatism, but Mr. Rau shows very clearly that, even supposing considerable further development to be probable, a central station is not justified in keeping in operation apparatus that is now out of date.

The use of a four-wire three-phase distribution in the manner suggested by Mr. Rau does not appeal to us. It is sufficiently difficult to maintain an approximate load balance on a three-phase system as ordinarily installed, and with each phase carrying a different class of service from the other two, as advised by Mr. Rau, the regulation problem would be much aggravated. The closest approach to ideal balance is obtained when each distinct class of service is divided equally between the three phases, and while this may entail more complex service connections than Mr. Rau's plan, any disadvantage thus incurred must be negligible compared with the difficulty of regulation under the other conditions.

Moreover, if two-wire feeders are run out from the station to centers of lighting distribution, as intimated in the paper, the chief advantage of the three-phase system—economy in copper—disappears, and the fourth ("neutral") circuit-connection on the generator becomes superfluous except as to the feeders for the motor load, if there should be any. With single-phase feeders for the lighting load, the two-phase system is as economical in copper as the three-phase system, and it is much easier to keep in balance. As to the motor load, there is not much choice between two phases and three. The latter affords the convenience of two voltages for starting, but this is not a controlling factor in the determination of the number of phases. A so-called compensator gives a better range of starting voltages, and some starting device is necessary for large motors, even on a four-wire three-phase circuit.

The Symbols "I" and "C."

The announcement made last month in this column concerning the adoption of *I* instead of *C* to represent current strength having called forth a number of inquiries concerning the origin of this use of the symbol *I*, it is thought that there may be many readers who may desire that information and yet feel diffident about requesting it. We therefore give it here. The International Electrical Congress, held at Chicago in 1893, recognizing the desirability of uniformity in the use of electrical symbols throughout the scientific world, undertook the task of providing a code of symbols that would be most generally acceptable in all countries. Upon careful consideration of the subject it became evident that the two symbols, *I* and *C*, had been so generally employed to represent, respectively, current and capacity, by scientists and pioneer investigators as to render it inadvisable to recommend any change in them. They had been used in much of the fundamental and permanently valuable literature extant, and it was considered impracticable to disregard the usage there observed, notwithstanding the very widespread use of *C* and *K* by other writers. The use of *I* was derived naturally from the word "intensity" (French, *intensité*; German, *intensität*), which has been employed by many eminent scientific writers from Ampére's time down to the present day to indicate current strength. The derivation of *C* as the symbol for capacity (French, *capacité*; German, *capacität*), is obvious.

Electric Traction for the New York Central.

The recent deplorable disaster in the tunnel of the New York Central & Hudson River Railroad Company drew out, of course, an avalanche of communications to the daily press, most of which contained suggestions of means for the prevention of a recurrence of the accident. The cause of the present accident, according to a report based on the resultant investigation, having been due to the obscuration of the danger signals by smoke from passing locomotives, most of the suggestions for securing future safety have naturally been in the direction of the use of electric motors for hauling trains over that section of the tracks located in the tunnel. With the cause of the accident we have nothing to do, but it is interesting to note that there was some diversity of opinion concerning the feasibility of applying electricity to the hauling of these trains, when there appears no reason why any difference of opinion as to the fundamental proposition should exist. The absolute practicability of electric traction for this class of work has been so thoroughly demonstrated as to render argument on the subject a mere waste of time.

The chief adverse comment on the proposed adoption of electric traction was based upon the alleged liability of electricity to cause fire in the event of a collision, and a recent conflagration in the tunnel section of the big Liverpool railway system was cited as an example of the dangers of electricity under such conditions, a large number of persons having lost their lives on that occasion. The fact in the Liverpool case, as reported, is that the fire was caused by the blowing of an unprotected fuse, which set fire to the woodwork, giving evidence of a piece of villainous construction work that any engineer should know better than to permit. With proper modern construction and the use of protected fuses, the danger of an electrical fire may be reduced to an almost negligible point. Moreover, an equipment on any such scale as that which would be required by the New York Central would properly include the feature of sectional supply conductors; the connection between each section and the main supply system being controlled from a signal tower and passing through an automatic circuit-breaker.

The most serious part of the New York Central's electrical problem is undoubtedly the disposition of the supply conductors from which the trains shall receive current. With the present arrangement of tracks in the New York yards, overhead conductors would be out of the question, and even the third-rail form of supply conductor, which would be the only practical means of connection thus far known, would be extremely difficult if not impossible to install. If the third rail should be used, the danger incident to the use of an exposed rail could be obviated by providing a protecting housing which shall prevent accidental contact with the rail from above while allowing free access to it laterally.

However, by removing all of the "active" track switches to a point above the congested district (which starts at the Grand Central Station) and running all trains into and out of that district on loop tracks, none of the tracks at the station and in the stretch immediately above it would cross each other. Then the use of a suspended conductor would be practicable. With such an arrangement all the trains could be hauled by steam locomotives outside of the congested district, and by electric locomotives within that district. Or the through trains could be drawn by the usual locomotives beyond the tunnel, and the suburban trains electrically equipped, their schedules being arranged so that for every steam-driven train going out of or coming into New York there would be a "local" train on the same "time" with it; the electric train would then be used instead of a separate electric locomotive to pull the steam train out or in between the Grand Central Station and some point beyond the congested district, the two trains running as one within the limits mentioned.

It is by no means intended to belittle the magnitude of the problem under discussion or to exaggerate the advantages of electric traction. The indisputable facts related to the present case, however, are that electric railway motors of any desired power can be obtained without the slightest trouble; either aerial or third-rail conductors can be used in the yard and the third rail in the tunnel, without involving extraordinary ingenuity or danger, by looping all of the tracks; the electrical fire risk, when proper constructional precautions have been taken, is far less than the fire risk from a steam locomotive, to say nothing of the danger from live steam in the locomotive boiler and (in winter) in the car-heating pipes, which danger would, of course, not exist if electric traction were used; the block-signal system can be arranged so as to enable any signal man to stop an electrically-driven train regardless of the movements or wishes of the engineer; with the current cut off the supply conductor by the signal-tower operator, a rear-end collision due to the momentum of a fast-moving train that had run over its block could cause no fire or electrical danger to life.

Armature Torque.

The statement that the armature torque of a motor is independent of its speed has been made so often that it is familiar to many students who scarcely know what it means. Seldom, if ever, is any saving provision added, for the possibly good reason that experienced or technically trained engineers understand the limitations of the statement. For the advantage of readers who are not familiar with the principles involved it may be well to point out that torque is directly proportional to the strength of the magnetic field in the air-gap, multiplied by the ampere-turns on the armature. For a given armature, therefore, in which the number of turns is a fixed quantity, the torque is proportional to the product of armature current and air-gap flux. When speed variations affect the armature current, then they affect the torque to the same extent.

In starting a shunt-wound constant-potential motor from standstill, an external resistance is commonly inserted in series with the armature in order to prevent an excessive rush of current through the relatively low resistance of the armature winding and brushes. The momentary rush of current will, of course, be equal to the impressed e.m.f. divided by the total resistance of the armature and rheostat, and this current will produce a starting torque equal to $I\ \Phi\ k$, I representing the current, Φ the air-gap flux, and k a constant which covers the number of turns in the armature winding and also the factor for reducing from metric to practical units. Obviously, in such a case the starting current can be adjusted to any desired value by choosing a suitable external resistance, and the starting torque is therefore independent of any speed at which the motor may run.

After the armature starts, however, the case is different; its counter e.m.f. cuts down the current and the torque is reduced almost proportionately to the increase of speed. In a few seconds a speed is attained at which the counter e.m.f. is such that the current that it allows to pass through is just sufficient to give the torque required by the load at that speed, and some resistance must be cut out in order to get any increase in speed. Ultimately all of the resistance is cut out, after which any change in speed will cause a change in torque. Thus, if the load be increased, it will retard the speed of the armature, and this retardation will reduce the counter e.m.f. and allow more current to flow, thus increasing the torque. The speed will almost instantly drop to such a rate as will allow enough current to pass to produce the torque demanded by the load.

THE CONSTRUCTION OF A SMALL STORAGE CELL.

BY H. F. SHEPHERD.

The accompanying sketches and description apply to a small storage cell which has been found to give excellent results in practice. One of these cells, built by the writer, has been used for igniting the charge of a gas engine, and had a capacity of a trifle over 2 volts and about 12 amperes. For the construction of the cell there are required about 1½ sq. ft. of sheet lead 1/16 in. thick; 1 lb. of red lead; 1 lb. of yellow lead or litharge; 1 lb. of sulphuric acid; 6 ins. of lead wire ¼ in. in diameter; 2 brass nuts, and a binding post.

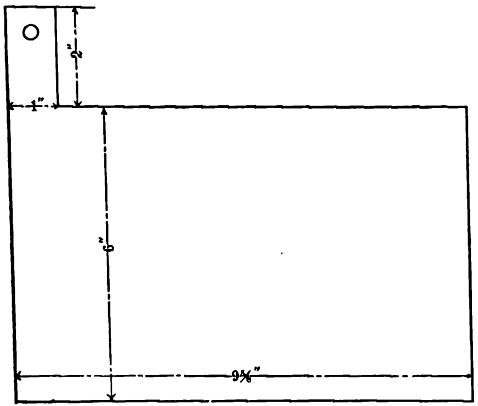

FIG. 1.—LEAD SHEET FOR OUTER SHELL.

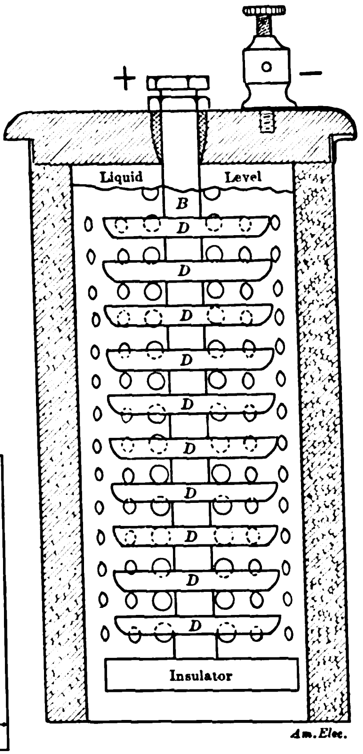

FIG. 4.—CROSS-SECTIONAL VIEW OF STORAGE CELL.

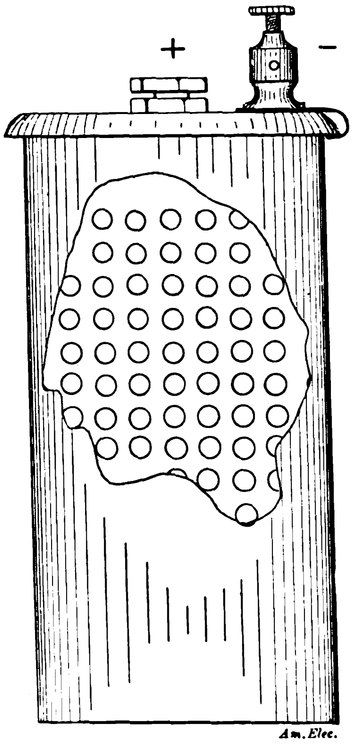

FIG. 6.—STORAGE CELL.

The outside shell of the cell is of sheet lead, and forms part of the negative electrode. This is made by cutting out of the lead sheet a piece 9⅝ ins. wide in one direction and 6 ins. wide in the other, with a lug or ear at one corner 2 ins. long and 1 in. wide, as shown by Fig. 1. This is rolled into the form of a cylinder 3 ins. in external diameter, which will give a lap of about 3/16 in. The edge that is 6 ins. wide should lap on the outside of the edge 8 ins. wide, and the joint should be soldered, taking care not to fuse the lead any more than is absolutely necessary.

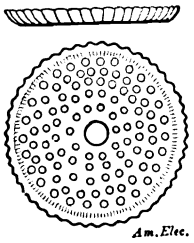

FIG. 2.—DISH.

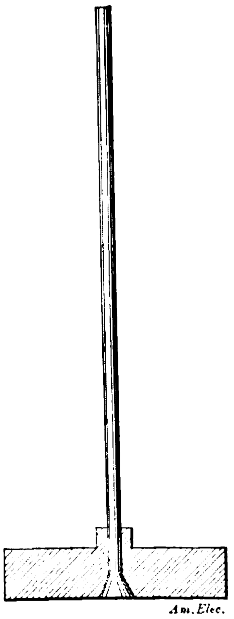

FIG. 3.—WOODEN DISK.

The bottom of the cell consists of a disc 3 ins. in diameter, to which the edges of one end of the cylinder should be fitted rather carefully and soldered. Next cut out a sheet of lead 5½ ins. x 8 ins. and punch this full of holes not larger than ¼ in. in diameter, and as close together as possible without making the lead so weak that it cannot be safely handled. The holes can be cut with an ordinary belt punch. This perforated sheet should be rolled into a cylinder 2½ ins. in outside diameter and 5 ins. long, the lap being soldered in three or four places, but not necessarily throughout its length. This cylinder should be set inside the first cylinder so as to leave an annular space of 3/16 in. uniform width between it and the interior wall of the main cup. This annular space should be filled with a paste made of litharge or yellow lead and dilute sulphuric acid, the acid being diluted by mixing it with ten times its weight of water. After packing the paste into position, let it dry thoroughly. The structure thus far obtained constitutes the negative plate of the cell.

Next take the piece of ¼-in. lead wire, thread it through a countersunk hole in the center of a wooden disc 2 5/16 ins. in diameter and ½ in. thick, beating a burr on the end of the lead wire which will fill the countersink in the wooden disc, as indicated in Fig. 3. This disc must be thoroughly boiled in paraffine. Then cut out 10 lead discs 2¼ ins. in diameter and drill a hole ¼ in. in diameter in the center of each disc. Flute the edges of each disc with a pair of pinchers so as to convert each one into a very shallow dish, as indicated by Fig. 2, and punch the bottoms of these dishes full of holes not over 3/16 in. in diameter. Thread the first dish on the wire, letting it rest on the shoulder of the wooden disc, and fill it with a paste made of red lead and dilute sulphuric acid. Next thread another dish on the lead wire, taking care not to push it entirely down on top of the first dish, and fill it also with red lead paste.

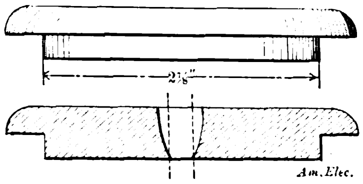

FIG. 5.—COVER.

It will be found a good plan to set two strips of rubber or thoroughly dry wood across the top of the first dish for the second dish to rest on until its paste has hardened. The holes in the center of the dishes should be a tight fit on the lead wire, so that the friction there will tend to prevent the dishes from slipping down. The succeeding dishes are slipped on the wire and filled with paste one by one, until the whole ten are in position, and the cell may then be assembled as shown by the cross-sectional view, Fig. 4, the electrolyte being put in before the cover is put on, of course. The electrolyte consists of dilute sulphuric acid exactly like that used in mixing the paste, and the level should be well above the topmost dish.

The cover of the cell may be made of hard wood or of rubber, preferably the latter, and should be of the shape shown by Figs. 4 and 5, the lower part of the cover fitting snugly the interior diameter of the outer lead shell. If the cover is made of hard wood it must be boiled in paraffine. The hole in the center of the cover, through which the lead wire passes, should be tapered, as indicated in Fig. 5, and filled with coal tar or pitch, so as to prevent the acid fumes from passing up through the hole and attacking the brass nuts on the outside.

The binding post should be of the wood-screw variety, and its screw should not be long enough to go entirely through the cover. The ear, 1 x 2 ins., shown in Fig. 1, is bent over on top of the cover and the binding post passed through the hole in the ear, the post being screwed down hard on the ear to form connection with the outer shell. The cover must have a vent hole about 1/16 in. in diameter in order to allow the escape of liberated gases. Fig. 6 shows the cell with the outer shell and the litharge paste cut away to reveal the perforated inner shell.

FIRING AND HANDLING STEAM BOILERS.

BY CHAS. L. HUBBARD.

Before starting a fire under a steam boiler the fireman should always first determine the water level by trying the gauge cocks, and if there are several boilers in the battery, each should be tried separately, as the water lines are liable to differ. An inspection of the water glass is a quicker and more convenient method, but not so reliable, on account of dirt, foam, etc. The safety valve should next be raised slightly to see that it is in order.

In case the fires have been banked they should be shaken slightly to clear the grates of ashes and clinkers; the drafts should then be opened and the fire allowed to come up somewhat before putting on fresh coal. If the fire has been allowed to go out, a new one may be started by throwing a thin layer of coal (if anthracite is used) over the entire grate, placing a piece of wood across the mouth of the furnace just inside the door, and laying other pieces at right angles to this with the ends resting upon it. This leaves a space under the wood for the admission of air. The wood is then covered with coal and a fire started with shavings, oily waste or any other combustible material at hand. The furnace doors should be kept open and the draft doors closed until the wood is well ignited, as this arrangement causes the flame to pass over and through the coal more thoroughly. After the fire is well started it should be spread or pushed back evenly over the grates, after which the furnace doors may be closed and the draft doors opened, and fresh fuel added as required. In the case of bituminous coal the wood should be placed directly upon the grates and all of the coal on top of it. The boiler should be warmed up gradually, in order to avoid strains caused by unequal expansion, which are likely to occur if steam is raised too rapidly.

In the case of water-tube boilers the fires may be forced more at the beginning if necessary, as there is less danger from the above causes, owing to the smaller amount of water in the boiler and the greater distance of the joints from the hottest part of the fire. After the fire is once started, the method of adding more coal depends upon the type of boiler, the kind of coal used, and the rate of combustion. There are three general methods of firing practiced, known as "alternate" or "side" firing, "spreading" and "coking."

In alternate firing, coal is spread so as to cover one side of the furnace, leaving the other side bright; at the next firing the process is reversed. By this method the hydrocarbons given off by the fresh coal are burned by the hot gases from the incandescent coal, and only a part of the furnace is cooled when the fresh coal is put in. This method of firing is especially adapted to cases where two furnaces lead to a common combustion chamber. Each furnace is fired regularly with a moderate amount of coal and the draft plates are left open until the gas has burned off.

Spreading is accomplished by firing small amounts of coal at short intervals and spreading the same evenly over the entire surface of the fire. The coal should be delivered where needed and not be disturbed afterward. It is customary to carry a somewhat thicker fire at the sides than at the center. Very satisfactory results can be obtained in this way by using the proper kind of coal, as the fire may be kept in good condition at all times. Care should be taken to keep the furnace doors closed as much as possible during the process of firing in order to prevent the entrance of cold air. For a short time after coal has been added, and while gas is being given off, the draft plates in the furnace doors should be opened to admit air above the fire.

These two systems are best adapted to anthracite coal, as it burns with comparatively little smoke. When bituminous coal is used the coking system is to be preferred. In this case the coal is piled on the grate just inside the furnace door and is allowed to coke from fifteen to thirty minutes, in order to distill the hydrocarbons. These gases are burned by admitting air through the draft plates. After the coking process, the mass is pushed back over the fire and fresh coal placed on the front of the grate. The air admitted cools the furnace somewhat and reduces the rate of evaporation, but this objection is not serious unless the boiler must be worked to its fullest capacity in order to furnish the required amount of steam.

The proper thickness of fire must be determined by trial and will depend upon the grade of coal used and the available draft. In the case of a strong draft and coarse coal the fire may be about a foot in thickness, but if the draft is weak or the coal fine, the thickness should not be more than three or four inches. With forced draft, a thicker bed of coal must be carried in order to secure a high rate of combustion. With the same draft, bituminous coal may be fired more thickly than anthracite. After having determined by experiment the best thickness of fire to carry, it should always be kept at that thickness. The rear of the grate should never be allowed to get bare, and air-holes in the fire should be covered over as soon as formed. If it becomes necessary to force a boiler, it may be done by firing smaller quantities of coal at shorter intervals. Never fire a large amount of coal and wait for the pressure to rise, for the introduction of fresh coal chills the furnace and retards combustion.

Keep the grates free from clinkers and ashes, but do not clean oftener than necessary. There are four tools used for cleaning the fire, namely, the "slice-bar," which is a long straight bar with the end flattened, and which is used to break up clinkers by thrusting it between the fire and the grate, and also for breaking up caking coal; the "prick-bar," which is similar to the slice-bar, except that the end is bent at right angles like a hook; this is used for removing ashes by running it up between the grate bars from beneath; the "clinker hook," as its name signifies, is used to haul the fire forward and to remove clinkers; and the "hoe" is used for a similar purpose.

When the fire is to be cleaned, the fireman should make sure that there is enough water and steam to last during the process. He then breaks up the clinkers with the slice-bar and removes the ashes with the prick-bar. Some firemen first push the fire to the rear and then clean the front of the grates, after which the coal is hauled forward and the rear of the grates cleaned. Others clean one side at a time instead of the front and rear. In either case the fire should be allowed to burn down before cleaning, but not so much but what it can be easily brightened up afterward. The dampers should be partly closed, so that the amount of cold air admitted shall be small. In order to prevent too great a drop in steam pressure, the work should be done as quickly as possible.

Banking the fire depends upon the condition of the fire, the length of time it is to be banked, and also somewhat upon the experience of the fireman himself. The usual method is to first clean and push the coal back into a small space near the bridge wall. It is then covered with fresh coal to a thickness varying with the time the fire is to remain banked. The dampers should then be closed and the furnace doors opened. When it is desired to start the fire again, the water level and steam pressure should be noted and the safety-valve lifted slightly to see that it is in working order. The fire should then be cleaned and the ashes cleared from the grate by means of the prick-bar. Coal may then be spread over the fire in a thin layer and the dampers opened. Ashes should never be allowed to accumulate in the ash-pit, for they may cause burning of the grates. In order to reduce the liability to such damage, some firemen make a practice of keeping a couple of inches of water in the ash-pit.

The state of the water level in each boiler should be tested frequently by means of the gauge cocks, and fresh coal should never be fired without having sufficient water in the boiler. The water-glass and gauge cocks should be kept in constant use, and the safety-valve should be of ample size and kept in free working order. The pointer of the pressure gauge should stand at zero when there is no pressure upon the boiler, and if it fails to do so should be adjusted by comparison with a standard gauge. In case the pressure rises above the maximum point indicated by the gauge and the safety-valve fails to blow off, the fires should be banked at once and the gauge and safety-valve tested. The fusible plugs should always be cleaned and scraped when the boiler is cleaned, else they may fail to work when needed.

All parts of the boiler exposed to the

fire should be kept clean and the tubes and flues swept as often as possible. The kind of fuel used will determine the frequency of cleaning, but it should be a rule never to allow a layer of soot or ashes to accumulate over one-sixteenth of an inch in thickness. Manhole and handhole covers should be removed frequently for the inspection of interior surfaces, and before replacing them all finished bearing surfaces should be cleaned and oiled. The boiler should be emptied once in two weeks at least, and oftener if the feed-water is impure. The surface blow-off should be used when there is no demand for steam. If the water is muddy or comes from a condenser, and contains oil, five or six inches of water should be blown out daily, but never under a high pressure. The blow-off cocks should be carefully watched, so that any leaks which occur from this source may be quickly detected. If the quality of the feed-water is such that there is a tendency to the formation of scale, proper means should be taken toward prevention. If it does form, however, it must be removed at frequent intervals. There are various methods of removing scale, which will be taken up in a future article.

When possible, there should be two independent methods of feeding the boiler, and both of sufficient capacity to do the required work alone in case of a break down or repairs. Whatever the method of feeding the boiler, the apparatus used should work as smoothly and continuously as possible. Feed valves and checks should be tested and cleaned at frequent intervals. Some means should always be provided for warming the feed-water before delivery to the boiler, in order to avoid excessive strains in the plates due to unequal expansion. If the feed-water positively cannot be warmed, it should be delivered into the boiler in such a manner that it will become thoroughly mixed with the warmer water before it comes in contact with the shell.

In case of low water, cover the fire with wet ashes or fresh coal if the ashes are not at hand. The fire may be drawn as soon as it can be done without increasing the heat, but not before. The safety-valve should not be lifted at such a time, neither should cold water be fed into the boiler; all conditions should be kept as uniform as possible until the fires can be checked and the boiler cooled down. Never fill a hot boiler with cold water, as leaks or fracture may result. Foaming may be stopped sometimes by closing the throttle or stop valves, keeping them closed until the water becomes quiet and shows a true level. In case the foaming is caused by dirty water, it may be remedied by blowing off and adding fresh water. If the boiler primes, lower the water level. A boiler should never be emptied while hot, as this will cause any sediment and grease present to bake on the heating surfaces.

The outside of a boiler should be inspected at regular intervals, especially if the location is damp or there is much brick-work in the setting. Water should be kept from the exterior of a boiler as much as possible, in order to prevent corrosion. All brick-work around the combustion chamber must be made tight, as the inward leakage of cold air is a source of serious loss. A careful lookout should be kept for cracks, blisters and defective joints, and if any appear they must be promptly attended to. If galvanic action between the water and the copper and iron is suspected, it may be prevented by hanging a piece of zinc in the boiler.

There are different opinions in regard to the best way of treating a boiler if it is to stand idle for some time. One method is to completely fill it with water in which a quantity of common soda has been dissolved. Another way is to empty the boiler and thoroughly dry it; then place trays of quicklime in the bottom.

ARMATURE TESTING BY DIVIDED CIRCUITS.

BY J. F. MOTZ.

The following methods of armature testing, which are in use by the writer, have proven extremely satisfactory and easy of application. The necessary appliances consist of a pair of horses on which to mount the armature, a telephone receiver, two sets of exploring commutator brushes, and an adjustable resistance coil or liquid resistance. The resistance should be sufficient to keep the current down to 8 or 10 amperes. The armature is mounted on the horses, of course, as indicated in the accompanying sketch. In order to locate a ground or short-circuit one of the leads from the source of current, which may be any direct-current circuit, is carried to the armature shaft through the adjustable resistance, and the other led to an improvised brush rig at the commutator end of the shaft, as shown in the sketch. The exploring brush should not cover more than one commutator segment. The telephone receiver is connected between the armature shaft and the exploring brush so that it is in shunt to the testing circuit.

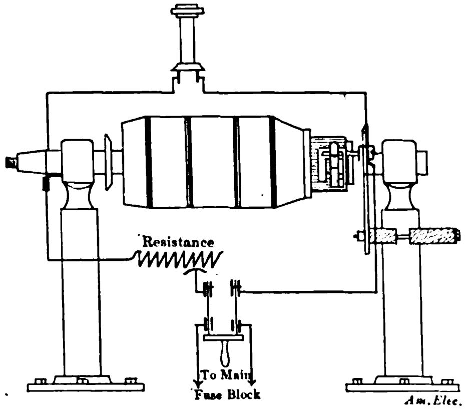

FIG. 1.—MOUNTING AND CONNECTIONS OF ARMATURE.

A circuit will be established, of course, from the line through the resistance, armature shaft, grounded armature coil and sound armature coils, brush and brush-holder, back to the other side of the line. It is evident that turning the shaft will vary the resistance of this circuit by putting more or less sound armature coils between the brush and the grounded armature coil. For example, when the armature is in the position shown in Fig. 2, the resistance from the brush to the shaft, through the grounded coil, will be highest, and the current shunted through the telephone receiver will be maximum, so that the click in the receiver will be loudest at this point. Turning the armature around slowly, it is easy to determine when the brush rests on the commutator segment corresponding to the grounded coil, in which case the click in the telephone receiver is faintest. It is ordinarily sufficient to simply hold the receiver to the ear and turn the armature over slowly by hand. The passage of the brush from one segment to the other of the commutator produces a click in the receiver which grows fainter and fainter as the defective coil is approached. In order to provide against injury to the telephone in case of accidental opening of the circuit, the magnet coil of the receiver may be rewound with about No. 24 B. & S. double silk-covered wire, and a small fuse inserted in series with the instrument.

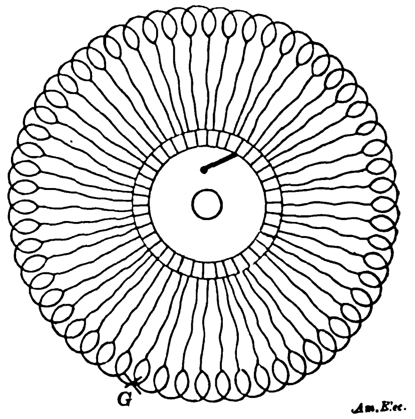

FIG. 2.—GROUNDED ARMATURE.

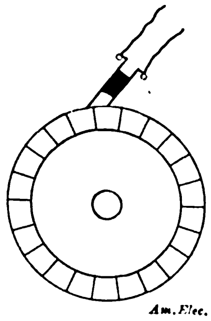

FIG. 3.—EXPLORING BRUSHES.

For testing out short-circuits the connections shown by Fig. 3 are used. Two exploring brushes are mounted on an insulating block, so that they touch the commutator precisely one segment apart. These are connected to the source of current through the adjustable resistance, and also to the telephone receiver. Upon rotating the armature it is easy to tell by the click in the receiver when the brushes rest on the segments corresponding to the short-circuited coil, the click being faintest at that point.

In order to avoid the necessity of using heavy currents, a dry battery and induction coil outfit may be employed as the source of testing current, the secondary terminals of the coil being substituted for the leads from the direct-current circuit. This would, of course, obviate all danger of damage to the telephone receiver.

The horses which hold the armature for testing are best made of heavy wrought-iron pipe, say 4 ins. in diameter, screwed into substantial flanges and having inserted in their upper ends iron forks lined with babbitt, or some other soft metal to prevent scratching the armature shaft.

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TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

OFFICE LOCATION AND OFFICE DISTRICT DIVISIONS.

When a telephone exchange consists of one office only, which will always be the case in small towns, the first point to determine is where the office building should be located in order to make the sum of the lengths of all the subscribers' lines a minimum. In order to have a specific name for this point, and as it is the center where all the telephone lines come together, it will be termed the "telephonic center." The modern cities of America, as well as the new parts of European cities, are laid out in squares, so that a sheet of cross-section paper is the most convenient medium by which to represent a city. Although cities like Boston, for example, would not directly conform to such a representation, some approximation could be made nevertheless.

In order to illustrate the method suggested for locating the exchange so as to obtain minimum length of wire, consider first an office having only two subscribers. Letting the lines of a piece of cross-section paper represent the streets of a city, and connecting the two subscribers by the shortest possible line which follows along the streets of the city, the exchange office may be located at any point on this line, or in either of the two subscribers' premises, because the sum of the distances from the exchange to the subscribers is always the same.

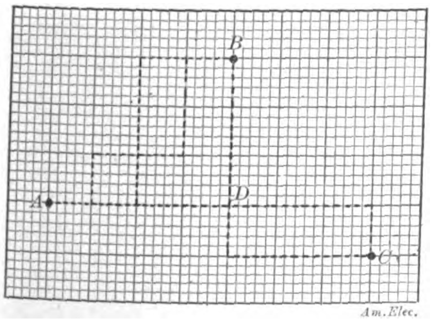

FIG. 1.—THREE SUBSCRIBERS.

With three subscribers, the best location can also be easily fixed, as indicated in Fig. 1, where the subscribers' stations are represented by the dots, *A*, *B* and *C*. Subscriber *A* can be connected with subscriber *B* over many different routes; three routes are shown by the dotted lines, and although all three follow partly different streets they are all of the same length, and it would be therefore legitimate to select any of these routes. The most rational course would be to select the one having the least turns, for a pole line as well as an underground conduit is costliest at the corners. Moreover, it is natural to give preference to that one of the two equal routes which, besides having the smallest number of corners, passes nearest to the third subscriber, *C*; that is the route which passes from *A* horizontally to the point *D* and then vertically up to *B*. Now, connecting the subscriber *C* to the point *D* by the route which has the smallest number of corners will give the shortest line between *C* and *A* as well as between *C* and *B*. The dotted lines show two such routes, and both are equally good. From this diagram, the best location for the office is evidently at the intersection, *D*.

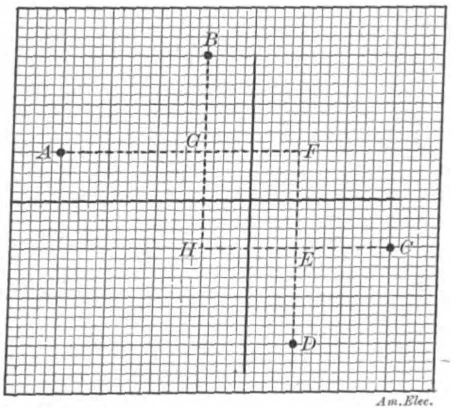

FIG. 2.—FOUR SUBSCRIBERS.

Next considering four subscribers, represented in Fig. 2 by the dots, *A B C* and *D*, it will be found that upon connecting the two pairs of subscribers by two lines having the least possible number of corners, and passing next to each other, the two routes shown by the dotted lines will be the ones to take. In such a case the telephonic center may lie in any point along the lines, *E F G H*, or within the square described by the lines, although this is not exactly true in practice, because it is always best to locate the office at a corner. Now, drawing two lines parallel with the streets and at right angles to each other, with their point of intersection inside the quadrilateral, *E F G H*, divides the subscribers into equal numbers north and south as well as east and west, as shown by the two full lines in the diagram. The subscribers may be moved outward or inward, but so long as they remain in their respective quadrants the telephonic center will remain unchanged. With five subscribers, the method of procedure is the same as with three; with six it is the same as with four, from which the conclusion may be drawn that the telephonic center of an exchange (the most favorable point for the location of an office) in the case of an even number of subscribers is found by dividing the total number of subscribers into two equal parts by a line parallel with the streets running east and west, and also dividing them into two equal parts by a line parallel to the streets running north and south.

This is illustrated better in Fig. 3, which shows 20 subscribers located haphazard. The line, *X X*, which runs east and west, divides the total number into two equal groups, and the line, *Y Y*, running north and south, also divides the total number into two equal groups, so that all four quadrants contain the same number of subscribers each. The theoretical telephonic center is, therefore, at the intersection of the lines *X X* and *Y Y*. In making such a diagram, the simplest method of procedure is to lay a ruler on the diagram, as at *A B*, and draw it down across the paper until it reaches a point where the equal division of subscribers is effected, then draw the line *X X*. Then pursue a similar course with the ruler vertical, starting at *C D* and drawing it horizontally across the paper. Inasmuch as the positions of the individual subscribers may be anywhere within a given quadrant, irregular shapes of streets within a quadrant do not affect the telephonic center of the system.

One might think that when an exchange has two offices the division of subscribers into four equal groups, as indicated, would indicate the two telephonic centers, but that is not true. It is true, however, that an equal number of subscribers should be on both sides of the two telephonic centers as well as north and south of the line, *X X*, of which there would be two, one for each office, and east and west of the line, *Y Y*, of which there would be also two. This gives one condition for the location of the telephonic centers, but another condition must be found, as there are two variable points.

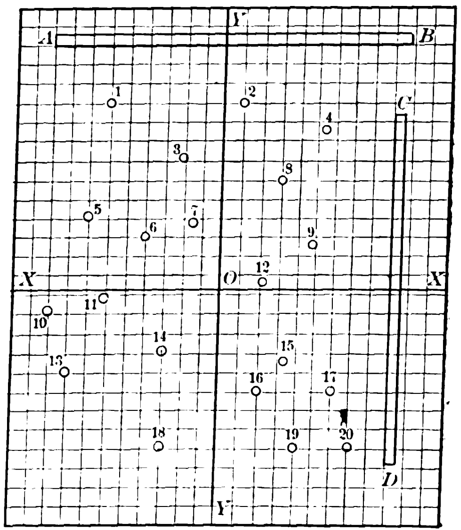

FIG. 3.—TWENTY SUBSCRIBERS.

Assuming temporarily that the lines need not be necessarily parallel with the streets, it will be found when the two offices are connected by a line and another line drawn across this one at right angles, that the second line will necessarily be the dividing line between the two office districts. Referring to Fig. 4, where *A* and *B* represent the two offices, and *P Q* the line dividing their districts, it will be evident that all subscribers on the *A* side of the line *P Q* should be connected to the office *A*, and those on the opposite side to the office *B*, as this would give the minimum length of subscribers' lines. This, therefore, gives the second theoretical condition of the problem, which is that a dividing line separating the two office districts must bisect a straight line drawn from one office to the other.

This condition, however, must be modified to take into account the fact that wires must be measured as the streets run, and not in air lines between two points. In Fig. 5, *A* and *B* again represent the two offices, and *P Q* is the theoretical line dividing the two districts. Conforming to the direction of the streets, however, the shortest route between *A* and *B* is either *A C B* or *A D B*. Measuring the line *A C B*, the point midway between *A* and *B* is located at *E*. Similarly, measuring from *A* to *B* by way of *D*, the point midway along that route is located at *F*. It will be found that any subscriber lying on the line *E F* will be the same distance from *A* as from *B*, measured as the streets run. It will be noticed that the line *E F* intersects the line *P Q* at the point where that line intersects the air line between *A* and *B*. As *E* and *F* are telephonically midway between *A* and *B*, all subscribers located on a line drawn perpendicular to *B C* at *E*, and those located upon a line drawn perpendicular to *A D* at *F*, will be equally distant from each office, so that the line *G E F H* is a correct boundary line between the two office districts, considering the fact that the subscribers' wires must follow the streets.

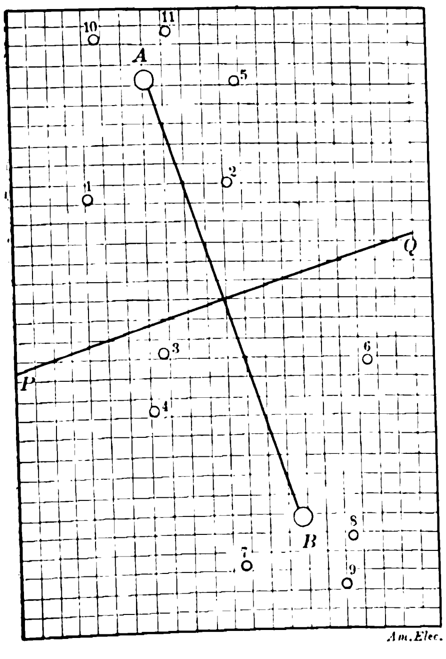

FIG. 4.—DIVIDED DISTRICTS.

The two conditions found so far, however, are not independent of each other, as the location of the dividing line assumes that the office locations have been found. Thus, the solution of the problem remains still undetermined. However, as subscribers are never distributed regularly over a geographical area, there will always be clusters of subscribers, or points where the distribution is denser than elsewhere. The two points of densest telephonic population should be picked out on the map by the eye and the two offices assumed to be located there. Should the map show somewhere a strip of very low "density" in subscribers, it would be best to assume this strip as the dividing line between the two office districts, leaving the location of the offices to be determined later.

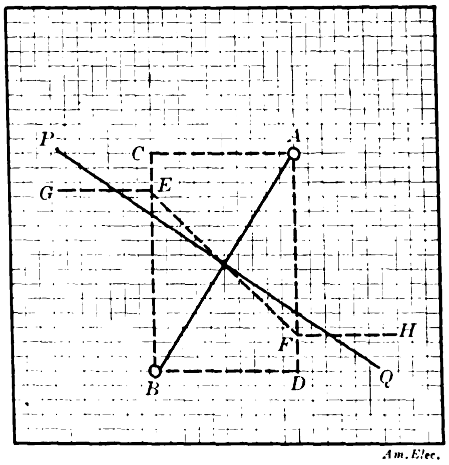

FIG. 5.—LOCATING THE DIVIDING LINE.

In the first case, where the offices are assumed, count the subscribers located between the two offices and also the subscribers on the outside of both. If the two sums are equal, one condition is fulfilled. Then locate the boundary by the method indicated in Fig. 5. If it comes midway between the offices, the second condition is also fulfilled. In the second case, where the dividing line is chosen first, locate the telephonic center for the district on each side of the dividing line just as though each district were an entirely independent exchange. When there are three or more offices, a number of conspicuously dense points should be chosen, corresponding with the number of offices. In following this method one will encounter the difficulty that each of the offices must be made equidistant from the others so that the lines along which equidistant subscribers are located will cut each other and parts of these lines will extend into the middle of an office district; these extensions must be left off.

For example, in Fig. 6, the line *C D E F* represents the theoretical dividing line between the districts of the offices *A* and *B*; the line *H I J K* similarly represents the dividing line between the districts of the offices, *G* and *A*, and also the line *L M N O* is the theoretical dividing line for the districts of the offices *D* and *G*. In the diagram those portions of the boundary lines which are "feathered" should be retained, and the portions which are left plain should be eliminated, as these pass into the heart of office districts. Of course these dividing lines are theoretical only. In practice they would have to follow streets and more correctly the center of streets, so as to have subscribers belonging in the *A* district, for example, on one side of the dividing streets, while the subscribers belonging in the district of another office would be on the opposite side of the street. Only one pole line or conduit would be required in a street, as the lines from the different districts could be carried, of course, on the same pole line or in the same conduit. Referring to the diagram, the three dividing lines meet at the point *P*, so that there is no difficulty in obtaining actual dividing lines which follow the streets. It is easy to add more offices in the same manner that the office *G* was added to the offices *A B*.

In the foregoing, two conditions have been deduced for the determination of the office location and the district dividing lines when there are two or more offices in an exchange. A third condition should be added, to wit: after the office locations and the dividing lines have been determined, the average length of subscribers'

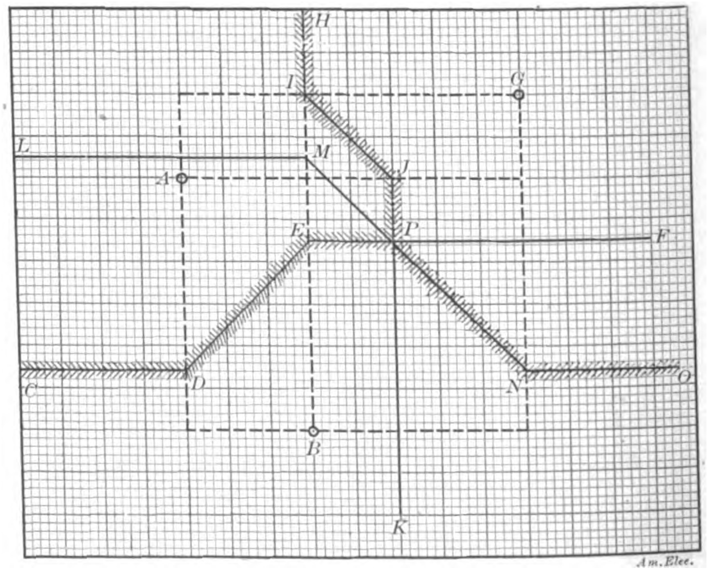

FIG. 6.—DETERMINATION OF PLURAL DIVIDING LINES.

line for each office multiplied by the number of subscribers served from that office, should be equal for all of the offices, in order to obtain a minimum total length of subscribers' line for the entire exchange.

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DETERMINING THE SIZE OF STRIP OR BAR CONDUCTORS.

The prime consideration, of course, in selecting the size of any electrical conductor is the energy loss due to its resistance. In the case of bus-bars or other conductors commonly made of copper strip, the "drop" per unit length of conductor is the starting point in the series of calculations. Knowing the percentage of the total energy that may be lost in the bar and the distance that the latter must carry the current, it is obviously a simple matter to determine the drop per inch or foot, according to the case, that is allowable in the conductor. Table I, herewith, shows the drop per inch in millivolts (thousandths of a volt) for annealed copper strip at several temperatures and a wide range of current densities. But in order that the temperature of the conductor shall not exceed the assumed temperature and give a greater resistance loss than was assumed, a sufficient area of radiating surface must be provided to dissipate the I^2R heat.

It has been found that bright strip copper will increase its temperature approximately 20° Fahr. when radiating heat at the rate of 0.036 watt per square inch of surface, and as this is ordinarily an imperceptible temperature rise it has been adopted in this article as the basis for bus-bars and similar conductors.

Taking a single inch of length, the radiating surface is evidently equivalent to the perimeter; thus, a bar having a cross-section ¼ in. × 2 ins. would have a "girth" or perimeter of 4½ ins., and each inch of its length would have a radiating surface of 4½ ins. As the loss in watts increases directly with the length of the bar or strap, and the radiating surface also increases in the same ratio, the heat radiation per square inch for a given current density is the same for one inch of length as for 100 feet, or any other length. Then, in order to keep the temperature rise within 20° Fahr., the perimeter of the bar or strip must be equal to the loss in watts per inch of length divided by 0.036; thus:

$$p = \frac{W}{.036} \ldots\ldots\ldots\ldots (1)$$

The loss in watts per inch is obviously equal to $V \times I$, V being the drop in volts per inch, so that the perimeter per ampere of current must be equal to $V \div 0.036$. Table II gives values of $V \div 0.036$ for conditions corresponding to those of Table I. It is only necessary, therefore, to multiply the constant corresponding to the current density and temperature by the actual current in order to find the perimeter required to radiate the desired amount of heat per unit of time. Thus, if a density of 750 amperes per square inch had been decided upon, and the temperature of the surrounding air were to be 85° and the current 1000 amperes, the perimeter of bar necessary would be found by multiplying the current, 1000, by the constant in the 85° column and opposite the density 750; the constant being .01525, the required perimeter would be 15.25 ins.

But besides having the proper perimeter, the conductor must have the proper cross-section to give the assumed density and drop. There is no simple relation between the perimeter and area of a rectangular section; the perimeter increases as the square root of the sectional area, and the relation of these two to the proportions of the cross-section are

$$\frac{p^2}{s} = \frac{4t}{w} + \frac{4w}{t} + 8,$$

where *t* is the thickness and *w* the width of the bar; and *s* is the area of the cross-section. As the right-hand term is a perfect square, its root would be taken, resulting in

$$\sqrt{\frac{p}{s}} = 2\left(\sqrt{\frac{t}{w}} + \sqrt{\frac{w}{t}}\right).$$

which is not alluring.

The easiest method, therefore, is to find the necessary cross-section to give the drop, and the necessary perimeter to afford the radiation desired, and then select a bar that will meet both requirements, without bothering with the relation between the two. Table III gives the cross-section and perimeter of each of the principal standard sizes of rolled copper, and by means of this a standard size can be chosen to fit any rational case. For example, suppose one had to transmit 500 amperes 40 inches with a drop of 18 millivolts in a room the temperature of which was 85°. This would be a drop of 0.45 millivolt per inch and a copper temperature of 105°. Table I shows that a current density of 600 amperes per square inch would come within the requirement for drop. Table II gives the constant .0122 as corresponding to the current density and temperature, and multiplying this by the current, 500, gives a perimeter of 6.1 ins. The density being 600 and the current 500, the cross-section must be not less than 500 ÷ 600 = 0.833 sq. in. Therefore the conductor must be of such size and shape as to have 0.833 sq. in. area of cross-section and 6.1 ins. of perimeter. Table III shows that a bar 5-16 × 2¾ ins. comes nearest to these requirements, both the section and the perimeter being a trifle more than required.

TABLE I.
Giving the drop in millivolts per inch length of annealed copper conductor.

Amp. per sq.in.	Temperature of the Copper Conductor. 70°	90°	105°	120°	135°	150°
500	.34	.354	.366	.377	.387	.4
525	.357	.372	.384	.396	.407	.42
550	.374	.39	.402	.415	.426	.44
575	.391	.407	.421	.434	.446	.46
600	.408	.425	.439	.452	.465	.48
625	.425	.443	.457	.471	.484	.5
650	.442	.461	.476	.49	.504	.52
675	.459	.478	.494	.509	.523	.54
700	.476	.496	.512	.528	.543	.56
725	.493	.514	.531	.547	.562	.58
750	.51	.531	.549	.565	.581	.6
775	.527	.549	.567	.584	.601	.62
800	.544	.567	.586	.603	.62	.64
825	.562	.585	.604	.622	.639	.66
850	.579	.602	.622	.641	.659	.68
875	.596	.62	.641	.66	.678	.7
900	.613	.638	.659	.679	.697	.72
925	.63	.655	.677	.697	.717	.74
950	.647	.673	.695	.716	.736	.76
975	.664	.691	.714	.735	.756	.78
1000	.681	.709	.732	.754	.775	.8
1050	.715	.744	.769	.792	.814	.84
1100	.749	.78	.805	.829	.853	.88
1150	.783	.815	.842	.867	.891	.92
1200	.817	.85	.878	.905	.93	.96
1250	.851	.886	.915	.942	.969	1.
1300	.885	.921	.952	.98	1.008	1.04
1350	.919	.957	.988	1.018	1.046	1.08
1400	.953	.992	1.025	1.056	1.085	1.12
1450	.987	1.028	1.061	1.093	1.124	1.16
1500	1.021	1.063	1.098	1.131	1.163	1.2
1550	1.056	1.099	1.135	1.169	1.201	1.24
1600	1.09	1.134	1.171	1.206	1.24	1.28
1650	1.123	1.17	1.208	1.244	1.279	1.32
1700	1.157	1.206	1.244	1.282	1.317	1.36
1750	1.192	1.24	1.281	1.319	1.356	1.4
1800	1.226	1.276	1.318	1.357	1.395	1.44
1850	1.26	1.311	1.354	1.395	1.434	1.48
1000	1.294	1.347	1.391	1.432	1.472	1.52
1950	1.328	1.382	1.427	1.47	1.511	1.56
2000	1.362	1.418	1.464	1.508	1.55	1.6

TABLE II.
Giving values of the constant *K*, by which to multiply the Current in order to find the Perimeter of conductor required for radiation. Temperature rise, 20°.

Amp. per sq.in.	Temperature of the Surrounding Air. 50°	70°	85°	100°	115°	130°
	Temperature of the Conductor. 70°	90°	105°	120°	135°	150°
500	.00946	.00985	.01017	.01047	.01076	.01111
525	.00993	.01034	.01067	.011	.0113	.01167
550	.0104	.01083	.01118	.01152	.01184	.01222
577	.01088	.01132	.01169	.01204	.01238	.01278
600	.01135	.01182	.0122	.01257	.01292	.01333
625	.01182	.01231	.01271	.01309	.01345	.01389
650	.0123	.0128	.01322	.01361	.01399	.01444
675	.01277	.01329	.01372	.01414	.01453	.015
700	.01324	.01379	.01423	.01466	.01507	.01556
725	.01371	.01428	.01474	.01518	.01561	.01611
750	.01419	.01477	.01525	.01571	.01615	.01667
775	.01466	.01526	.01576	.01623	.01668	.01722
800	.01514	.01575	.01627	.01675	.01722	.01778
825	.01561	.01625	.01677	.01728	.01776	.01833
850	.01608	.01674	.01728	.0178	.0183	.01889
875	.01655	.01723	.01779	.01833	.01884	.01945
909	.01703	.01773	.0183	.01885	.01937	.02
925	.0175	.01822	.01881	.01937	.01991	.02056
950	.01797	.01871	.01932	.0199	.02045	.02111
975	.01844	.0192	.01982	.02042	.02099	.02167
1000	.01892	.0197	.02033	.02094	.02153	.02222
1050	.01986	.02068	.02135	.02199	.0226	.02333
1100	.02081	.02166	.02236	.02304	.02368	.02444
1150	.02175	.02265	.02338	.02408	.02476	.02555
1200	.0227	.02363	.0244	.02513	.02583	.02667
1250	.02365	.02462	.02542	.02618	.02691	.02778
1300	.02459	.0256	.02643	.02723	.02798	.02889
1350	.02554	.02659	.02745	.02827	.02906	.03
1400	.02648	.02757	.02847	.02932	.03014	.03111
1450	.02743	.02856	.02948	.03037	.03122	.03222
1500	.02837	.02954	.0305	.03142	.03229	.03333
1550	.02932	.03053	.03152	.03246	.03337	.03444
1600	.03027	.03151	.03253	.03351	.03444	.03556
1650	.03121	.0325	.03355	.03456	.03552	.03667
1700	.03216	.03348	.03457	.0356	.0366	.03778
1750	.0331	.03447	.03558	.03665	.03767	.03889
1800	.03405	.03545	.0366	.0377	.03875	.04
1850	.035	.03644	.03762	.03875	.03983	.04111
1909	.03594	.03742	.03863	.03979	.0409	.04222
1950	.03689	.0384	.03965	.04084	.04198	.04333
2000	.03783	.03939	.04067	.04189	.04306	.04444

Formula Rd ÷ .036 = K. R. = Resistance per cubic inch.

The use of the tables may be facilitated by the following rules and formulas:

A.—Find current density permissible by the allowable drop, in Table I.

B.—Divide density by current, to get cross-section, "s."

C.—Find constant in Table II corresponding to the density and room temperature; multiply it by the amperes to be carried, in order to find the perimeter, "p," of the conductor.

TABLE III—Giving Areas and Perimeters of Rectangular Cross Sections.
Figures horizontally in line with *s* are cross section areas.
Figures horizontally in line with *p* are cross section perimeters.

Width.		Thickness of conductor, inch measure.										
		1/16	⅛	3/16	¼	5/16		⅜	7/16	½	⅝	¾
½	s	.0312	.0625	.0937	.125	.1562	s	.1875	......	......	......	......
	p	1.125	1.25	1.375	1.5	1.625	p	1.75	......	......	......	......
⅝	s	.039	.0781	.1172	.1562	.1953	s	.2344	......	......	......	......
	p	1.375	1.5	1.625	1.75	1.875	p	2.	......	......	......	......
¾	s	.0469	.0937	.1406	.1875	.2344	s	.2812	.3281	.375	......	......
	p	1.625	1.75	1.875	2.	2.125	p	2.25	2.375	2.5	......	......
⅞	s	.0547	.1093	.164	.2187	.2734	s	.3281	.3828	.4375	......	......
	p	1.875	2.	2.125	2.25	2.375	p	2.5	2.625	2.75	......	......
1	s	.0625	.125	.1875	.25	.3125	s	.375	.4375	.5	.625	.75
	p	2.125	2.25	2.375	2.5	3.625	p	2.75	2.875	3.	3.25	3.5
1⅛	s	.0703	.1406	.2109	.2812	.3515	s	.4219	.4922	.5625	.7031	.8437
	p	2.375	2.5	2.625	2.75	2.875	p	3.	3.125	3.25	3.5	3.75
1¼	s	.0781	.1562	.2344	.3125	.3906	s	.4687	.5469	.625	.7812	.9375
	p	2.625	2.75	2.875	3.	3.125	p	3.25	3.375	3.5	3.75	4
1⅜	s	.0859	.1719	.2578	.3437	.4297	s	.5156	.6016	.6875	.8593	1.0312
	p	2.875	3.	3.125	3.25	3.375	p	3.5	3.625	3.75	4.	4.25
1½	s	.0937	.1875	.2812	.375	.4687	s	.5625	.6562	.75	.9374	1.125
	p	3.125	3.25	3.375	3.5	3.625	p	3.75	3.875	4.	4.25	4.5
1¾	s	......	.2187	.3281	.4375	.5469	s	.6562	.7656	.875	1.0937	1.3125
	p	......	3.75	3.875	4.	4.125	p	4.25	4.375	4.5	4.75	5.
2	s	......	.25	.375	.5	.625	s	.75	.875	1.	1.25	1.5
	p	......	4.25	4.375	4.5	4.625	p	4.75	4.875	5.	5.25	5.5
2¼	s	......	.2812	.4219	.5625	.7031	s	.8438	.9844	1.125	1.4062	1.6875
	p	......	4.75	4.875	5.	5.125	p	5.25	5.375	5.5	5.75	6.
2½	s	......	.3125	.4687	.625	.7813	s	.9375	1.0937	1.25	1.5625	1.875
	p	......	5.25	5.375	5.5	5.625	p	5.75	5.875	6.	6.25	6.5
2¾	s	......	.3437	.5156	.6875	.8594	s	1.0312	1.2031	1.375	1.7187	2.0625
	p	......	5.75	5.875	6.	6.125	p	6.25	6.375	6.5	6.75	7.
3	s	......	.375	.5625	.75	.9375	s	1.125	1.3125	1.5	1.875	2.25
	p	......	6.25	6.375	6.5	6.625	p	6.75	6.875	7.	7.25	7.5
3½	s	......	......	.6562	.875	1.0937	s	1.3125	1.5312	1.75	2.1875	2.625
	p	......	......	7.375	7.5	7.625	p	7.75	7.875	8.	8.25	8.5
4	s	......	......	.75	1.	1.25	s	1.5	1.75	2.	2.5	3.
	p	......	......	8.375	8.5	8.625	p	8.75	8.875	9.	9.25	9.5
4½	s	......	......	......	1.125	1.4062	s	1.6875	1.9687	22.25	2.8125	3.375
	p	......	......	......	9.5	9.625	p	9.75	9.875	10.	10.25	10.5
5	s	......	......	......	1.25	1.5625	s	1.875	2.1875	2.5	3.125	3.75
	p	......	......	......	10.5	10.625	p	10.75	10.875	11.	11.25	11.5
6	s	......	......	......	1.5	1.875	s	2.25	2.265	3.	3.75	4.5
	p	......	......	......	12.5	12.625	p	12.75	12.875	13.	13.25	13.5
7	s	......	......	......	1.75	2.1875	s	2.625	3.0625	3.5	4.375	5.25
	p	......	......	......	14.5	14.625	p	14.75	14.875	15.	15.25	15.5
8	s	......	......	......	2.	2.5	s	3.	3.5	4.	5.	6.
	p	......	......	......	16.5	16.625	p	16.75	16.875	17.	17.25	17.5

D.—In Table III find the size of conductor having a cross-section and perimeter nearest the values obtained under Rules B and C.

Formulas:

$$\frac{I}{d} = s \therefore \frac{I}{s} = d \therefore ds = I$$

$$IK = p \therefore \frac{p}{K} = I$$

$$\therefore ds = \frac{p}{K}$$

I = current; d = density; s = cross-section area; p = perimeter; K = constant in body of Table II or Table IV.

When a strap conductor must carry a current a considerable distance, it will be found necessary to allow a greater rise in temperature than 20°. Table IV is calculated on the basis of a 30° rise, in which case the radiation can be carried to 0.058 watt per square inch; it is to be used in place of Table II where necessary.

It is not intended to intimate that these tables and calculations give the hair-splitting results that the number of decimal places might suggest. The tables have been computed for perfectly still air conditions, which never exist in an ordinary dynamo room; for polished copper, which is seldom found in active service; and for unimpeded radiation, which is a rare condition. Consequently, the actual results obtained in practice will differ from those given by the tables.

TABLE IV.

Giving values of the constant *K* by which to multiply the Current to find Perimeter of conductor required for radiation. Temperature rise 30°

Amp. per sq.in.	Temperature of Surrounding Air.					
	40°	60°	75°	90°	105°	120°
	Temperature of Conductor.					
	70°	90°	105°	120°	135°	150°
500	.00587	.00611	.00631	.0065	.00668	.00689
525	.00616	.00642	.00663	.00683	.00702	.00724
550	.00646	.00672	.00694	.00715	.00735	.00759
575	.00675	.00703	.00726	.00748	.00768	.00793
600	.00705	.00733	.00757	.0078	.00802	.00828
625	.00734	.00764	.00789	.00813	.00835	.00862
650	.00763	.00795	.0082	.00845	.00869	.00897
675	.00793	.00825	.00852	.00878	.00902	.00931
700	.00822	.00856	.00883	.0091	.00935	.00966
725	.00851	.00886	.00915	.00942	.00969	.01
750	.00881	.00917	.00947	.00975	.01002	.01035
775	.0091	.00947	.00978	.01008	.01036	.01069
800	.00939	.00978	.0101	.0104	.01069	.01104
825	.00969	.01009	.01041	.01073	.01102	.01138
850	.00998	.01039	.01073	.01105	.01136	.01173
875	.01027	.0107	.01104	.01138	.01169	.01207
900	.01057	.011	.01136	.0117	.01203	.01242
925	.01086	.01131	.01167	.01203	.01236	.01276
950	.01115	.01161	.01199	.01235	.01269	.0131
975	.01145	.01192	.01231	.01268	.01303	.01345
1000	.01174	.01222	.01262	.013	.01336	.01379
1050	.01233	.01284	.01325	.01365	.01403	.01448
1100	.01292	.01345	.01388	.0143	.0147	.01517
1150	.0135	.01406	.01451	.01495	.01537	.01586
1200	.01409	.01467	.01515	.0156	.01603	.01655
1250	.01468	.01528	.01578	.01625	.0167	.01724
1300	.01526	.01589	.01641	.0169	.01737	.01793
1350	.01585	.0165	.01704	.01755	.01804	.01862
1400	.01644	.01712	.01767	.0182	.01871	.01931
1450	.01703	.01773	.0183	.01885	.01937	.02
1500	.01761	.01834	.01893	.0195	.02004	.02069
1550	.0182	.01895	.01956	.02015	.02071	.02138
1600	.01879	.01956	.02019	.0208	.02138	.02207
1650	.01937	.02017	.02083	.02145	.02205	.02276
1700	.01996	.02078	.02145	.0221	.02272	.02345
1750	.02055	.02139	.02209	.02275	.02338	.02414
1800	.02114	.022	.02272	.0234	.02405	.02483
1950	.02172	.02262	.02335	.02405	.02472	.02552
1900	.02231	.02323	.02398	.0247	.02539	.02621
1950	.0229	.02384	.02461	.02535	.02606	.0269
2000	.02348	.02445	.02524	.026	.02673	.02759

Formula Rd ÷ .058 = K. R = Resistance per cubic inch.

But the difference will invariably be *in favor* of the bus-bar or other conductor, because the computations are based on the most unfavorable possible conditions, excepting unimpeded radiation, the importance of which is relatively small. The application of the tables, therefore, cannot result disadvantageously, and if done intelligently will effectually prevent the use of conductors having insufficient radiating surface and conductivity.

Lessons in Practical Electricity

THE MAGNETIC CIRCUIT.

In engineering practice it is generally desired to concentrate the power of an electromagnet within a relatively small space, and this is not possible with a straight magnet because of the distance between its poles. Consequently, magnets are made in some form the genus of which is the shape shown by Fig. 1. The magnet here shown is of the "horseshoe" or ∩ type, and almost all magnets used industrially are variants of this type. The advantage is that the proportion of total path that consists of air is small, and the reluctance of the magnetic circuit is therefore much smaller than would otherwise be possible.

A magnet has two functions: one is to furnish a magnetic field of force for the generation of electromotive force; the other is to move some object through space by means of the tractive power of magnetic flux. If a bar of iron or other material susceptible to magnetization be held near the poles of a magnet, as at *A*, Fig. 1, the flux will pass from the "north" magnet pole across to the bar, through the latter and across to the "south" magnet pole, forming a closed magnetic circuit, as indicated by the dotted line, L_c L_g L_a L_g. The result will be a pull upon the bar in the direction of the magnet, due to the effort of the flux to shorten its path, or improve its quality. A bar or other piece thus attracted is called an "armature."

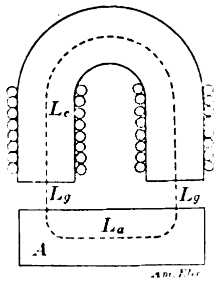


FIG. 1.—HORSESHOE MAGNET AND ARMATURE.

A magnet cannot be made to push a piece of magnetic material bodily away from it because that would not improve the quality of the magnetic path, which is the constant tendency of magnetic flux. The pull exerted by the flux upon an armature is naturally in a direction parallel to the lines of force in the air-gap between the magnet and the armature. Thus, in Fig. 1, the armature, *A*, would be pulled directly toward the ends or poles of the magnet, the flux taking practically the direction indicated by the dotted lines in Fig. 2, which shows a more commercial form of magnet.

The pull exerted by the flux when the armature is in contact with the magnet poles is proportional to the square of the magnetic density over the contact surface of the armature. The formula for magnetic traction under this condition is

$$P = \frac{B^2A}{72{,}134{,}000} \text{ or } 13{,}863\, B^2A\, 10^{-12},$$

where $P =$ pull in pounds; $B =$ magnetic density at the contact surface, and $A =$ the area of the contact surface in square inches. When the armature is not in contact with the poles, the leakage renders it impractical to determine what the density is at the surface of the armature, so that a formula for the pull under that condition would have no practical value. The same is true of a simple solenoid, such as that represented in Fig. 3.

An armature consisting of an iron tube (or a rod) if partly inserted in a coil, as shown, will be pulled further into the coil by the magnetic lines of force in their effort to improve the magnetic circuit. If the tube should be moved up to a position where the ends project equal distances, assuming the upper head to have a hole in it to allow this, the pulling would cease, because no further movement would improve the path of the lines of force. It will be of much practical value to the student to remember that the movement of a piece of iron or steel can be caused by magnetic attraction only when such movement improves the quality of the magnetic circuit, which may be accomplished either by shortening the circuit or bringing material of greater permeability or cross-section within it.

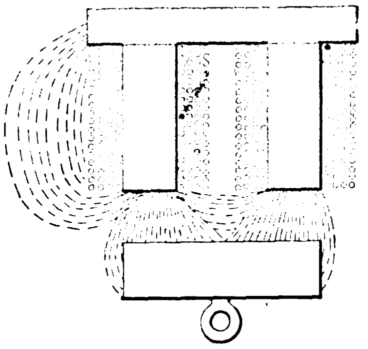


FIG. 2.—DISTRIBUTION OF FLUX.

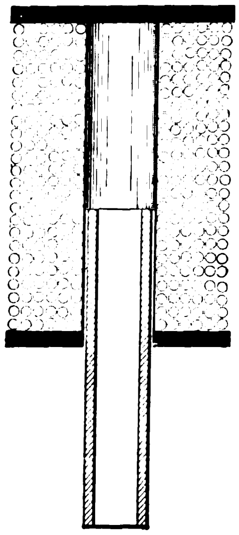


FIG. 3.—SIMPLE SOLENOID.

As explained in the preceding Lesson, the specific ability of iron to "conduct" the magnetic lines of force, that is, the permeability, decreases as their density increases, requiring a greater magnetomotive force per thousand lines at a high

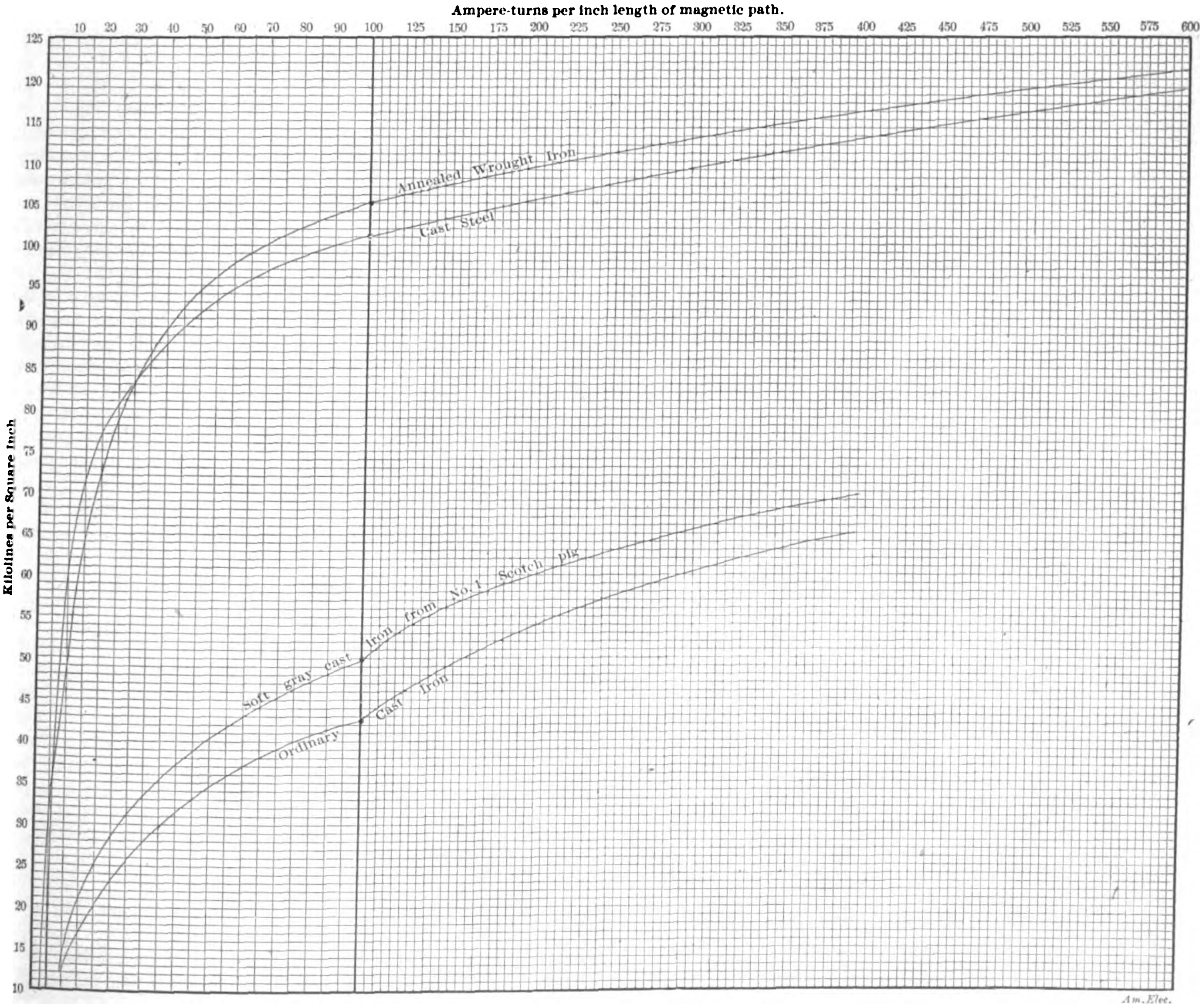


FIG. 4.—SPECIFIC EXCITATION-DENSITY CURVES FOR AVERAGE GRADES OF CAST IRON, CAST STEEL, AND WROUGHT IRON.

density than at a low one. In considering the dimensions of a magnet for any purpose whatever, therefore, the density at which the iron is to be worked must be first assumed, at least tentatively, before the exciting force can be ascertained. If the density be too low, the magnet will be unnecessarily large and cumbersome; if it be too high, the exciting force (ampere-turns) will be very great, requiring either an excessive quantity of wire or great strength of current.

The only way by which a magnet can be intelligently constructed is to begin by plotting "excitation curves" of the iron or steel that is to be used; from these the ampere-turns for any density may be read off at a glance. Fig. 4 herewith is such a diagram, four curves being given. Each curve indicates the ampere-turns per inch of length required to produce a magnetic flux of given density in the material specified; where the curve crosses an intersection of a vertical and a horizontal line, the figures at the top of the vertical line are the number of ampere-turns required to produce the density at the left of the horizontal line.

For example, the curve for cast steel crosses the intersection of the vertical line marked 90 with the horizontal line marked 100; this indicates that in order to produce 100,000 (the figures at the side are kilolines, *i. e.*, actual lines ÷ 1000) lines per square inch of cross-section in this grade of cast steel, 90 ampere-turns are required for each inch of length. This, of course, does not include the ampere-turns required by other parts of the magnetic circuit.

Thus, in the case of the magnet in Fig. 1, the magnetic circuit is divided into three parts—the magnet core, the armature and the air-gaps. In such a case, the density in each section of the magnetic circuit must be assumed, the ampere-turns for the length of each section ascertained, and the three values added, to obtain the total ampere-turns. As previously stated, magnetic leakage renders it almost impossible to estimate the density in the armature or at its surface; this is also true of the air-gap density. But for the purpose of illustrating the principle, we will assume that 25 per cent of the lines leak around through air and do not pass through the armature. Supposing the magnet core area to be 2 sq. ins., the length of path L_c within it 12 ins., and the material wrought iron; the length of each air-gap to be ¼ in. and the effective area 4 sq. ins.; the cross-section of the armature 3 sq. ins., the average length of path L_a 5 ins., and the material soft gray cast iron. Then the respective ratios of path area would be, magnet 1, air-gap 2, armature 1½. With 25 per cent of the flux going elsewhere, the air-gap and armature would carry only 75 per cent of the flux carried by the magnet core. The ratios of density therefore would be, magnet 1, air-gap, .75 ÷ 2 = ⅜, and armature, .75 ÷ 1½ = ½.

Assuming a density of 90,000 lines for the magnet core, which is a common value in practice, the following theoretical results would be obtained:

	Magnet core.	Air-gaps.	Armature.
Density	90,000	33,750	45,000
Ampere-turns per inch length of path	40	10,574*	74
Length of path	12	¼ + ¼	5
Ampere-turns	480	5,287	370

Consequently the total ampere-turns required would be 480 + 5287 + 370 = 6137.

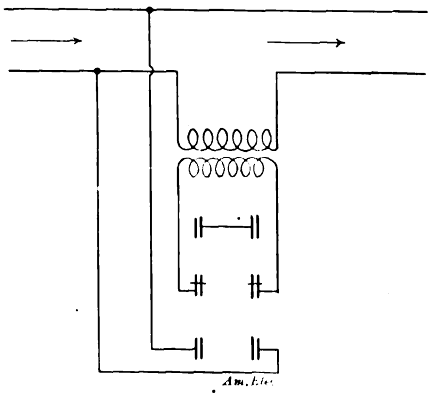
It must be remembered that the leakage and other basic values above assumed are purely arbitrary, and taken merely to illustrate the principle of estimating the excitation of a magnetic circuit. Also, that the curves in Fig. 4 were plotted from tests made with particular specimens of iron and steel, and do not apply universally to all grades of these metals. (The specimens tested, however, were of average qualities used in the manufacture of dynamos and motors.)

Letters on Practical Subjects

Booster Transformer Switch Connections.

To the Editor, American Electrician:—

In the early numbers of last year's volume, connections for a boosting transformer were discussed to a considerable extent, and all of the diagrams that were submitted at that time were based on the general plan of opening the primary and short-circuiting the secondary of the transformer when it was desired to throw it out of use. I enclose herewith a diagram for accomplishing the cutting out of the transformer, which differs somewhat radically from the previous diagrams in that the primary terminals of the transformer are disconnected from the line and short-circuited when it is desired to cut the transformer out. It is obvious that this arrangement will work, for the reason that the transformer would, of course, be selected of such size that the main line current would be within the capacity of its secondary winding; consequently, with the primary short-circuited the current through the secondary could not exceed the carrying capacity of that winding, and the same is consequently true of the primary circuit. This arrangement is, of course, open to the objection that the secondary winding will cause a slight drop in the line by reason of its resistance.



BOOSTER TRANSFORMER SWITCH CONNECTIONS.

H. E. Ryder.

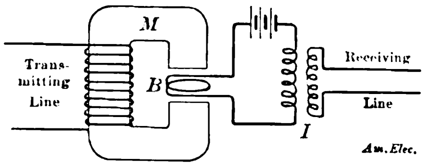
Marlborough, Mass.

◆

Suggestion for a Telephone Repeater.

To the Editor, American Electrician:—

One of the most attractive problems in telephony is the invention of a telephone repeater which shall be operative and at the same time relatively simple. It has occurred to the writer that such an instrument might be made, having for its basic principle the peculiar property of bismuth, which was discovered by Righi; namely, that of changing its resistance when subjected to the influence of a magnetic field. The accompanying sketch indicates the germ of such a repeater. In the diagram *M* is a laminated magnet core with a small air-gap in one side; *B* is a spiral of bismuth wire located in the air-gap and so disposed that the magnetic flux will not induce any e.m.f. in the coil, as this would oppose the influence upon the induction coil due to its change in resistance; *I* represents the winding of the usual induction coil. The magnetization of the core *M*, of course, fluctuates with the fluctuating currents from the transmitting line, and these fluctuations in flux cause variations in the resistance of the bismuth coil *B*, which act upon the induction coil like the variations in resistance of an ordinary transmitter. The writer has had opportunity to make only one or two preliminary experiments with this apparatus, and is therefore not in position to say whether or not a practical repeater can be constructed on these lines. The suggestion is offered, however, in the hope that it may incite some one to take up the problem who is in a position to investigate thoroughly its possibilities.



TELEPHONE REPEATER.

Ernst Adler.

Vienna, Austria.

◆

Mr. Cooper's Trouble.

To the Editor, American Electrician:

I believe the following will explain the trouble Mr. R. G. Cooper mentioned in the last number of the American Electrician as a similar case came under my notice. The two circuits previous to the installation of the new generator were both running 1040 volts primary, while the new generator was 2080 volts primary. Most of the transformers were G. E. Type H, wound for 1040 or 2080 volts primary, while the 52-volt transformer was only wound for 1040 volts primary, and as soon as the generator voltage got near normal the excessive current through the primary coil of the 1040-volt transformer burned the insulation off and thus practically short-circuited the line.

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*Ampere-turns for air = 0.3133 × B × L, as explained in the December Lesson.

B. A. Freeman.

Lewistown, Mont.

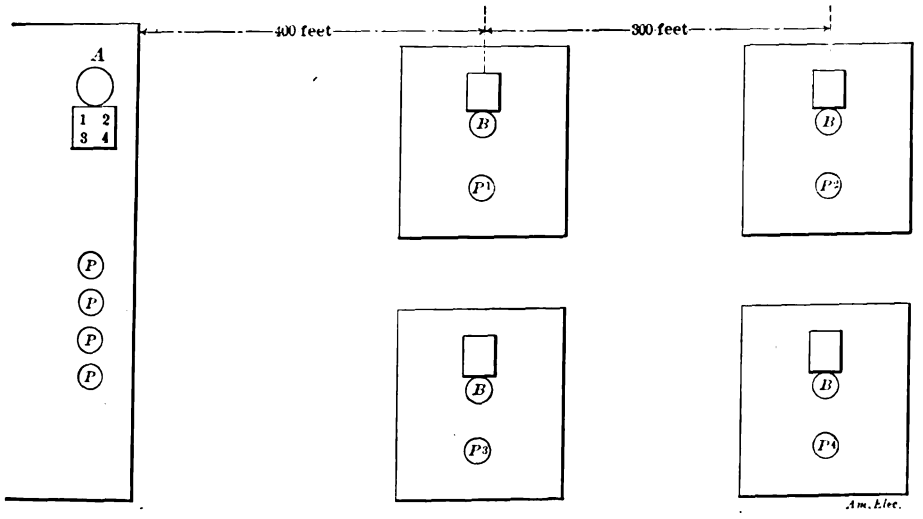
A Problem in Annunciator Wiring.

To the Editor, American Electrician:—

I enclose herewith a diagram for a problem which some of your readers will perhaps find interesting. Referring to the diagram, *A*, is a four-point annunciator which is to be rung by the pushes P^1 P^2 P^3 and P^4. The bells, each of which is indicated by the letter *B*, must be rung by the four pushes marked *P*, and located immediately below the annunciator, each of these pushes ringing one of the distant bells, but not the annunciator bell. The problem is not simply to wire up the bells and push buttons so that they will work, but to accomplish this with the smallest number of wires and without the aid of any auxiliary mechanical appliances. The writer had occasion to install such a system some time ago, the reliability of which was so important that it was considered necessary to provide two complete circuits, each circuit supplied from an individual battery. It will probably add to the interest of the problem to include this feature.

S. C. De Witt.

Sydney, N. S.



PROBLEM IN ANNUNCIATOR WIRING.

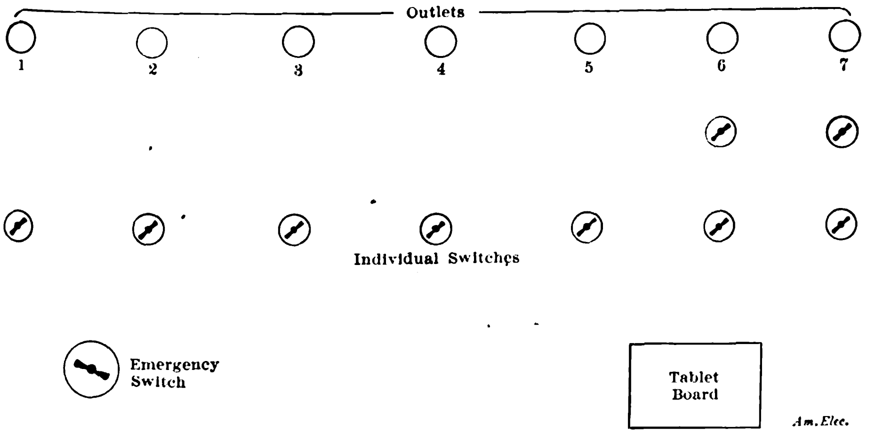
Another Problem in Lamp Control.

To the Editor, American Electrician:—

Mr. Sutter's "Problem in Lamp Wiring," which was published in the December number, and solutions of which appeared last month, has reminded me somewhat of a case which occurred some time ago in my own experience. In this case there were seven outlets to be wired for individual control in the usual manner, two of them to be controlled from two different points, and an emergency switch to connect all of the outlets with the circuit regardless of the positions of the individual switches. The accompanying diagram shows the outlets, switches and main tablet board, the relative positions of the outlets and switches being arranged so as to make plain the relations between them. The outlets 1, 2, 3, 4 and 5 are controlled by the single switches below them; outlets 6 and 7 are controlled by the two switches immediately below them, the usual two-station method of control being used here. Both terminals of each outlet must be carried to the tablet board and fused there. All of the switches must be stock switches that can be purchased of any general supply house. Of course, those who have solved Mr. Sutter's problem will not find any great difficulty in arranging the connections for the first five outlets; the chief point in the present problem is the arrangement of the connections for outlets 6 and 7 in conjunction with the other connections.

J. A. Cavanaugh.

Niles, Mich.



PROBLEM IN LAMP CONTROL.

Mr. Thompson's Mishap.

To the Editor, American Electrician:—

I want to make a correction on my letter published in your last issue. I assumed Mr. Thompson's dynamo to be a shunt-wound machine, which just as likely may not be the case. The action of an alternating current on a compound machine is as follows:

When the alternating current opposes the direct current, it will tend to enhance the field through the shunt coils, and to reverse or weaken it through the series coils. But reversing an armature current in the time corresponding to the frequency of alternating currents in use would cause the armature to have a high reactance and little effect would be produced on the machine, except a momentary cessation of the direct current. When the alternating impressed voltage acts in unison with the direct voltage, the alternating current will tend to reverse the field through the shunt coils and enhance it through the series coils. This causes more or less neutralization of the field. The machines now being in series a heavy current will flow, and the field will be reversed by the armature reaction minus the remaining opposition due to the series field winding.

Allegheny, Pa. P. M. Gallo.

Divided Control for Electric Gas Burners.

To the Editor, American Electrician:—

I have two automatic electric gas burners, one downstairs and one upstairs, that are now connected as shown by the enclosed diagram (Fig. 1). The common return of the two magnets of each burner is grounded on the gas pipe, of course, so that the diagram does not show the

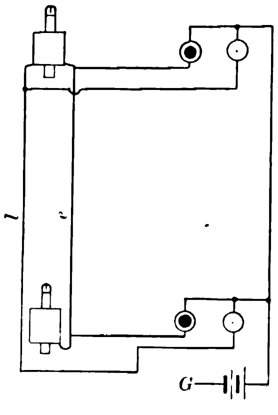


FIG. 1.—ELECTRIC GAS IGNITERS.

ground connection. The two wires, *l* and *e*, running from one burner to the other, are connected to the underground terminals of the lighting and extinguishing magnets respectively. As the sketch plainly shows, both burners may be lighted or extinguished from either push-button station, one of which is upstairs and the other downstairs. I would like to change the connections so that the downstairs button will light and extinguish both burners, and the upstairs buttons will light and extinguish only the upstairs burner, and I should be very much obliged if you or any readers of the American Electrician will suggest some way of doing this without using a separate switch or running any additional wires.

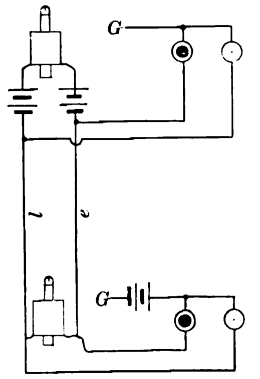


FIG. 2.—ELECTRIC GAS IGNITERS.

I. Bond.

Chicago, Ill.

[Two ways of accomplishing Mr. Bond's object suggest themselves. One is to put in two additional batteries, as indicated in Fig. 2, and the other is to use ordinary push-buttons upstairs and two-point push-buttons downstairs, as indicated in Fig. 3. The latter plan is, of course, the more practical of the two. In Fig. 2 it is obvious that the upstairs buttons operate the upstairs burner by means of the upstairs batteries, and that the downstairs buttons operate both burners by means of the two sets of battery. In Fig. 3 individual control is secured by separating the lighting and extinguishing wires of the two burners at the downstairs push buttons; the total number of wires in the latter case is exactly the same as in Mr. Bond's diagram. We shall be glad to have suggestions from readers as to any other method of carrying out Mr. Bond's idea.—Editor.]

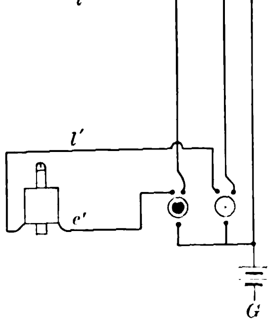
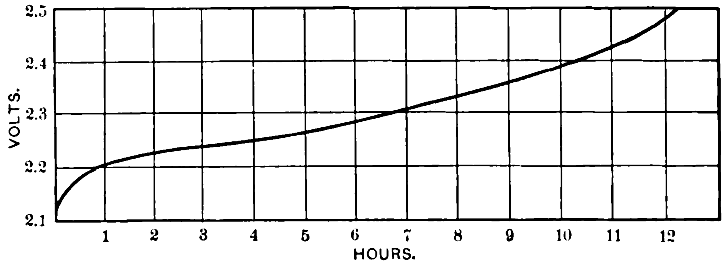


FIG. 3.—ELECTRIC GAS IGNITERS.

Electrical Catechism

661. How can the positive and negative terminals of a battery or dynamo be distinguished?

In the storage battery the positive plates have a brownish or chocolate appearance, while the negative plates are gray or slate colored. The polarity of a battery or dynamo may be tested by connecting the terminals to two pieces of lead or other metal dipped in acidulated water; bubbles of gas will appear at both pieces, the most appearing at the terminal connected with the negative terminal of the battery or dynamo. If the test metals are of lead, the piece connected with the positive terminal will become coated with a brown deposit, and that connected with the negative terminal will become gray or slate colored. An easier method of determining polarity is to use a voltmeter of the permanent magnet type which has its terminals marked; if the positive terminal of the battery is connected with the positive terminal of the voltmeter and the negative to negative, the voltmeter needle will be deflected in the right direction, otherwise it will move backward. The chemical paper or potato test is also convenient.



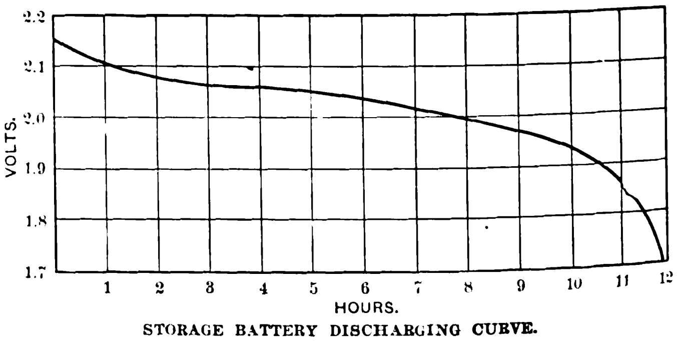
STORAGE BATTERY CHARGING CURVE.

662. How can one tell whether a storage battery is working properly?

Experience counts for much in such work. The appearance of the plates is a good indication of the condition of the battery. When the color is uniform and of the proper gray and brown shades, the battery is probably all right. The acid should be tested with a hydrometer occasionally to see that the solution is of the right strength, not less than 1.15 when the battery is discharged, and not more than 1.27 when it is fully charged, and it should be adjusted by the addition of dilute acid or of clean water, as the case requires. The standard density of electrolyte for any given battery is generally specified in the printed directions. The solution should always cover the plates ½ in. or more. The cells should not be allowed to discharge lower than 1.8 volts per cell, and in charging the pressure should not be carried higher than 2.5 volts or 2.6 volts per cell. If one cell is found to give lower voltage than others, it is probably caused by some foreign substance falling into the cell and bridging across from positive to negative plate and so discharging the cell, or changing the acid. Any metal falling into the liquid will be dissolved and secondary actions will be apt to injure the cell. Sometimes the active material or sulphate shed from the plates is allowed to collect at the bottom of the cell to such a depth as to touch the plates and so cause a local circuit which will discharge the cell. Such a cell should be cleaned and then fully charged by itself. If the plates become covered with a whitish scale, the cell has "sulphated" from being discharged to too low voltage, or from the acid being too strong; this reduces the capacity of the battery and may be removed by charging the cells for a longer time than usual, making them boil for some time until the plates resume their normal color. The makers will generally supply full instructions for the care of their cells.

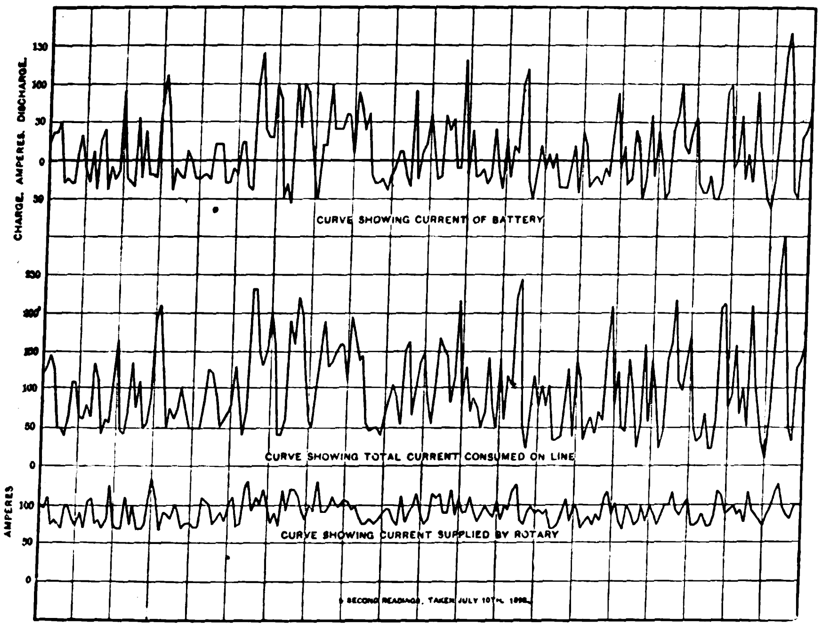
663. How is the current from a battery regulated?

Batteries are generally designed to supply a circuit at constant e.m.f., and the current is then controlled by the resistance of the line and attachments. As the battery becomes discharged, its voltage gradually drops off. The accompanying curve shows how the voltage drops when the discharge current is kept constant at the normal capacity of the battery. In central station batteries it is usual to provide enough cells to supply the required voltage when all are discharged down to the safe limit of 1.8 volts per cell. The cells at one end are provided with terminals leading to a switch, so that the total number of cells in the working circuit may be varied at will. At the beginning of the discharge, when all the cells are fully charged and each cell furnishes



STORAGE BATTERY DISCHARGING CURVE.

about 2.2 volts, it takes only fifty cells to furnish 110 volts; but as the cells discharge, their voltage falls, and it is necessary to move the "end cell" discharge switch so as to cut in another cell. A new end cell is then cut in for each drop of two volts in the total pressure. Since these end cells are in use a shorter time than the main battery, they become charged sooner and it is necessary to have also an end cell charging switch. At the beginning of the charge, all of the end cells are in circuit; the one on the end discharging for the shortest time, becomes fully charged before any of the others, and should be cut out of the circuit; the next cell likewise becomes charged soon and is cut out, and so on with all of the end cells until at the end of the charge only the cells of the main battery are in circuit. By having separate end cell switches for charging and for discharging, it is possible to keep the battery connected with the main circuit both while it is charging and while it is discharging. In the case of batteries for lighting railway trains and for some other purposes, there is no need for end cells, since the load on the battery is usually greatest at the early evening when the battery is fully charged and drops off as the battery discharges. In telephone exchanges, the battery should be kept well charged, so that the discharge never reaches the part of the curve where the voltage drops rapidly.



CURVES SHOWING REGULATING EFFECT OF STORAGE BATTERIES.

664. For what purposes are storage batteries used?

They are used largely for replacing the more expensive primary cells formerly used for operating telegraph, telephone, fire alarm and police systems, for operating small motors, medical coils and similar portable apparatus, for operating motors and lights on automobiles, cars and boats; for steadying fluctuating loads on central stations and isolated plants; for furnishing light and power; for increasing the maximum capacity of dynamo plants operated by steam or water power; to furnish a reserve power for emergency. Storage batteries will return from 40 per cent. to 80 per cent. of the energy supplied in charging, and thus are valuable auxiliaries in electric power plants where the load varies through wide limits, the batteries being charged when the load is small and when charging power can be developed at little additional cost, and supplying current when the load is greatest and when the value of additional power is highest. When the load fluctuates rapidly, as is the case with street railways and electric elevators, the battery acts as a sort of fly-wheel, taking a charge when the load is small and the voltage high, and delivering current when the load is heavy and the voltage drops. The accompanying curves illustrate such action of a battery.

665. In what way does electricity cause chemical action?

The current may cause chemical action directly by electrolysis, or indirectly by its heating effect. An electric current has no chemical effect while passing through a solid conductor; when current passes through any liquid conductor other than an elementary substance, such as a melted metal, the liquid is decomposed and chemical action appears at one or both electrodes. Gases seem to carry electricity by convection, the atoms or ions carrying positive and negative charges between the electrodes. In some cases, especially where the gases are hot, there seems to be an electrolytic action similar to that occurring in liquids, causing the combination or separation of atoms to form new compounds.

666. What is an ion?

All substances are composed of very minute particles known as molecules, which in turn are composed of still smaller elementary particles called atoms. Until recently the molecule had been looked upon as being the smallest particle of matter that could exist alone or in a free state, the atoms never remaining as free atoms, but always uniting with other atoms of the same or of different elements so as to form molecules. Recent physical investigations indicate that in every solution there exist numbers of free atoms or groups of atoms smaller than molecules, which are called ions. The ions tend to appear at the electrodes, those at the anode being called anions, those at the cathode being called cations. Each ion is believed to carry a static charge, by which it is attracted to the oppositely charged electrode. A theory which is now coming into general acceptance is that, in the case of elementary gases, the passage of an electrical discharge breaks up the atoms, which have heretofore been considered as the ultimate particles of matter, into positive and negative ions, the negative ion being only a small chip forming about one one-thousandth part of the original atom, while the remainder of the atom becomes the positive ion; each of these charged particles may gather around itself a number of molecules and travel toward the electrode. Thus, in an elementary gas, such as hydrogen or oxygen, an ion may be a small chip of an atom, or the remainder of the atom, or either of these together with a group of other attracted molecules. In general, an ion may be said to be a small charged particle of matter.

667. What is electrolysis?

Electrolysis is the decomposition of conductors by the passage of current, occurring at the surface in contact with the liquid conductor. When the liquid contains a metallic compound in solution, the metal is usually deposited on the cathode and the remaining part of the compound is deposited at the anode. The general rule is that metals travel with the current. In many cases there are secondary reactions, so that the ions, originally liberated by the current, form other combinations before they can be secured at the electrodes. In many cases electrolysis is undesirable and would be prevented if practicable, as in the case of damage to underground metal pipes by railway currents.

668. What are the laws of electrolysis?

(1.) The amount of chemical action is equal at all parts of a circuit; that is, the chemical action is independent of the location in the circuit, provided the current is equal in all parts.

(2.) The amount of an ion liberated in a given time is proportional to the strength of the current.

(3.) The amount of an ion liberated at an electrode in one second is equal to the strength of the current multiplied by the "electro-chemical equivalent" of the ion.

The first two laws mean that the chemical effect produced is proportional to the quantity of current multiplied by the time, so that 10 amperes acting for one hour produce the same result as 5 amperes acting for two hours. Explanation of the third law involves some chemical knowledge of the elements. The second and third laws are named after their discoverer, Faraday.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Will sal ammoniac cells freeze? H. J. W.

Not at any temperature ordinarily experienced.

Can a bell be attached directly to a 100-volt alternating-current circuit so that it will ring if the voltage rises above 100? A. L. S.

No; a relay would have to be interposed between the bell and the circuit.

Can alternating current at 110 volts be used for gas engine ignition? (2) At what point of the piston stroke should the spark be made at the igniter? W. M.

Not satisfactorily. (2). Immediately after the crank reaches the inner center.

Why may an arc-light dynamo be short-circuited without damage, while a constant-potential dynamo cannot be so treated? A. J.

Because the armature reaction is so high that any abnormal increase of current will "kill" the field; this is not true of constant-potential dynamos.

Please give directions for mixing sulphuric acid for storage batteries. (2). To which plates is the red-lead paste applied? L. A. V.

Pour concentrated sulphuric acid very slowly into water, making the proportion one-tenth acid and nine-tenths water by weight. (2) To the positive plates.

How can hard rubber be repolished after it has become tarnished? W. E. B.

Try sweet oil and putty powder, buffing the rubber with a silk buff and applying a final polish with sweet oil. If the rubber has lost its color and turned gray or greenish gray, the color cannot be restored.

What densities are generally used in the field magnet, air-gap and armature core of fan motors? V. A. Y.

The field densities range from 50,000 to 90,000 lines; the air-gap densities from 10,000 to 20,000 lines, and the armature core densities from about 30,000 lines to double that number, in square inch measure.

Is the function of a motor governor to increase the speed of an engine or to increase its power? J. F. B.

The function of any governor is to keep the speed of the engine as nearly constant as possible, and in order to do this it increases the power of the engine as the load increases, by admitting more steam to the cylinder.

How many lamps will a 2000-volt, 1500-light alternator maintain if the e.m.f. is reduced to 1000 volts? H. E. B.

If the reduction in voltage is accomplished by changing the armature connections, the machine will maintain the same number of lights as before; if it is accomplished by changing the speed, it will only maintain one-half the original number.

What is the best oil for insulating an induction coil? (2). Can single cotton-covered wire be used in the secondary of the 6-in. coil described in the AMERICAN ELECTRICIAN for January, 1897? E. J.

Either transil oil or boiled linseed oil. (2) No; when insulated wire is used in the secondary winding it should be double silk-covered, no matter what the size of the coil.

What causes small pin sparks between the segments of a commutator when the brushes do not spark? The sparks continue between the segments after they have passed the brushes. J. H. B.

The commutator has not been set up tight enough or else the shellac in the mica insulating strips has dried out, leaving small interstices in which carbon dust collects. This trouble almost invariably occurs with commutators which have not been baked after assembling and then retightened.

Will a bipolar dynamo operate as well with the series winding on one pole as with the winding divided into two coils, one on each pole, the shunt winding being thus divided? R. C.

Such an arrangement unbalances the field, causing the pole with the series winding on it to attract the armature core more strongly than the other pole does; this results in some increase in the bearing friction. While in practice the disadvantages are not serious, it is preferable from every standpont to divide the series winding and put one-half on each pole.

How can I ascertain the proper weight for the rim of a fly-wheel on an engine driving an electric-light dynamo, where the load is comparatively steady? C. K.

A formula which will serve under average conditions is the following

$$\frac{22{,}500 \times A \times s \times p}{R^2 \times D^2} = W.$$

In this formula *A* is the area of the piston in square inches; *s* is the stroke in inches; *p* is the mean-effective steam pressure; *R*, the number of revolutions per minute; *D*, the outside diameter of the wheel in feet; and *W* is the weight of the metal in the rim of the fly-wheel.

How can the size of wire be determined for a feeder which supplies two or more distributing boards, when the distributing boards are not all located at or very near the extreme end of the feeder? H. R. W.

Such an arrangement would not be very good practice, but fair results could be obtained by making the size of wire between each pair of neighboring tablet boards such as to make the drop one-tenth of one per cent in that section of the feeder. Then figure the wire for the main portion of the feeder between the switchboard and the nearest tablet board for the total drop, minus the aggregate of drops between the tablet boards.

Can a shunt-wound dynamo be operated in parallel with a compound-wound machine? (2). Why is alternating current better for transmission than direct current? (3). Can one wire of a direct-current circuit be run in an individual conduit pipe without heating? H. L. R.

Yes; but not very satisfactorily, as the machines will not divide the load equally and hand regulation of the shunt machine may be required. If the compound-wound machine is heavily over-compounded, it will probably be impossible to work the two together at all. (2) Because currents of extremely high potential can be generated and transmitted, permitting the use of small line wires, and the high potentials can be transformed at the far end of the line to working potentials for distribution without the use of moving apparatus. (3) Yes.

What is the magnetic saturation point of nickel? (2). What is the theory regarding the nature of X-rays? (3). What are Becquerel rays? (4.) Do not Hertzian waves correspond in some respects to sunlight? R. C. J.

Between 2500 and 3500 lines of force per square inch of cross-section. (2) Investigations thus far made tend to show that they are transverse ether vibrations similar to light and radiant heat rays, but of very short wave lengths. (3) Invisible light rays of an ultra-violet character emitted by fluorescent substances after exposure to light. (4) Yes; the angle of incidence is equal to the angle of refraction, for example, and the waves may be reflected from one parabolic reflector to another and brought to a focus. They may also be refracted by an asphalt prism, like light waves.

What proportion of the total power does a single wattmeter indicate in a three-phase line, and in a six-phase line? (2). How many wattmeters are necessary to indicate the total power of a balanced polyphase system? (3). How many are necessary for an unbalanced polyphase system? W.

$\sqrt{\text{One-third}}$ of the total power in a three-phase circuit, and $\sqrt{\text{one-sixth}}$ in a six-phase circuit. $\sqrt{1/3} = 0.577$; $\sqrt{1/6} = 0.408$. (2) One wattmeter less than the number of phases. With a perfectly balanced system, however, it is not necessary to measure the total power; the reading of a single meter multiplied by the square root of the number of phases is sufficient. (3) One meter less than the number of phases.

Why does a railway motor run hotter when the line voltage is below normal than when it is normal? (2). Why does a three-phase induction motor run hot when operated at half voltage? The rotor is of the squirrel-cage type. R. A. I.

Because the speed on any given notch of the controller is below normal and the efficiency is therefore lower than it would be normally. Consequently, the heat losses in the motor per unit of work actually performed are greater. Moreover, if there are grades, the speed of the machines being slower while on grades, the car will take longer to get up a grade, and the temperature of the motors will rise to a higher point than if the car went up in the length of time possible at normal speed. (2) Because the torque per ampere of current is approximately proportional to the voltage. Consequently, at half voltage the machine requires practically twice the amount of current to perform a given amount of work that it would require at normal voltage.

THE BRIGHTON GAS ENGINE.

Fig. 2, herewith, is a semi-sectional elevation of a very compact and substantially built type of gas engine which is manufactured by the Pierce-Crouch Engine Company, New Brighton, Pa. Fig. 3 is a cross-sectional plan view of the engine; Fig. 4 a sectional elevation, on a larger scale, of the rear end of the cylinder, showing the valve construction; and Fig. 5 an illustration of the throttling type of governor. The engine is of the four-cycle type and the larger sizes are provided with either throttling or "hit-and-miss" governors, as preferred by the purchaser. As the front view of the engine shows, it is of very simple and massive construction. The crank pin discs form the central portions of the fly wheels, and the strain between the cylinder and the main bearings is resisted in a straight line by the sides of the engine bed. The bearings are of the self-oiling type, with chain oilers. The crank pin is oiled through a straight duct of ample size, leading from a circular groove in the hub of one of the fly-wheels, to which groove oil is supplied by a sight-feed lubricator mounted on the cap of one of the main bearings.

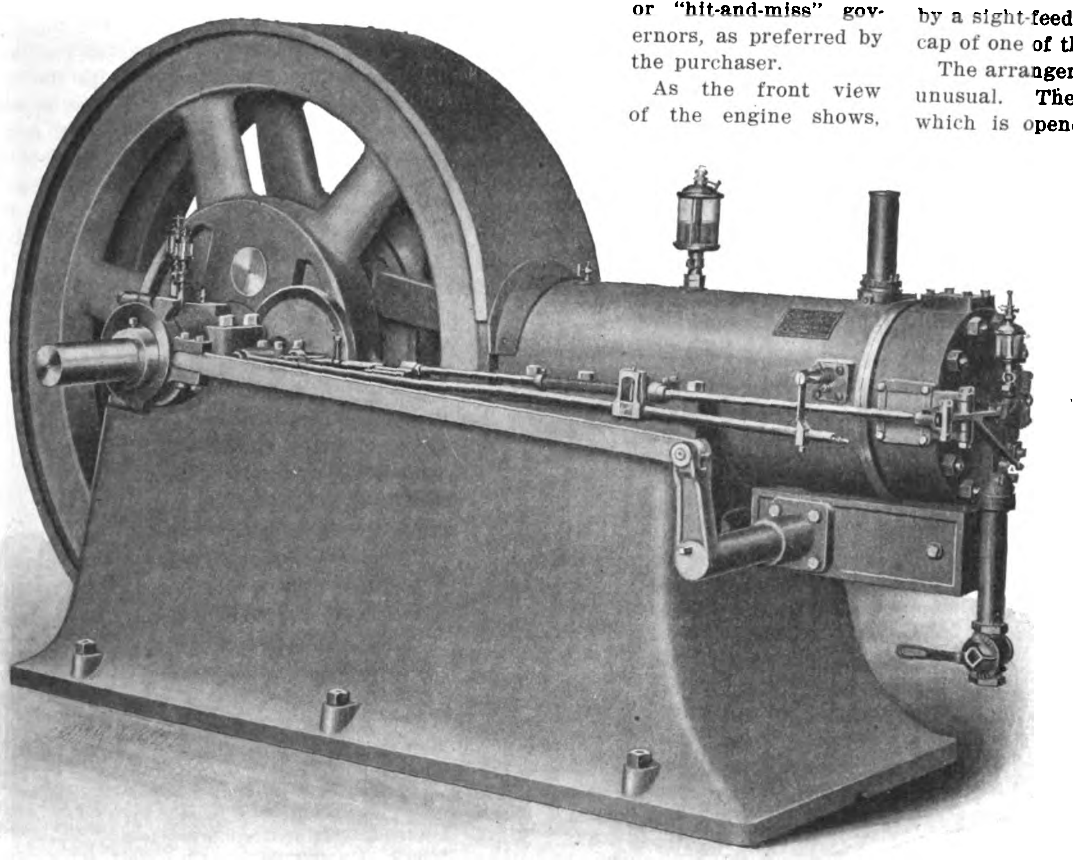


FIG. 1.—FRONT VIEW, STANDARD HORIZONTAL TYPE BRIGHTON GAS ENGINE.

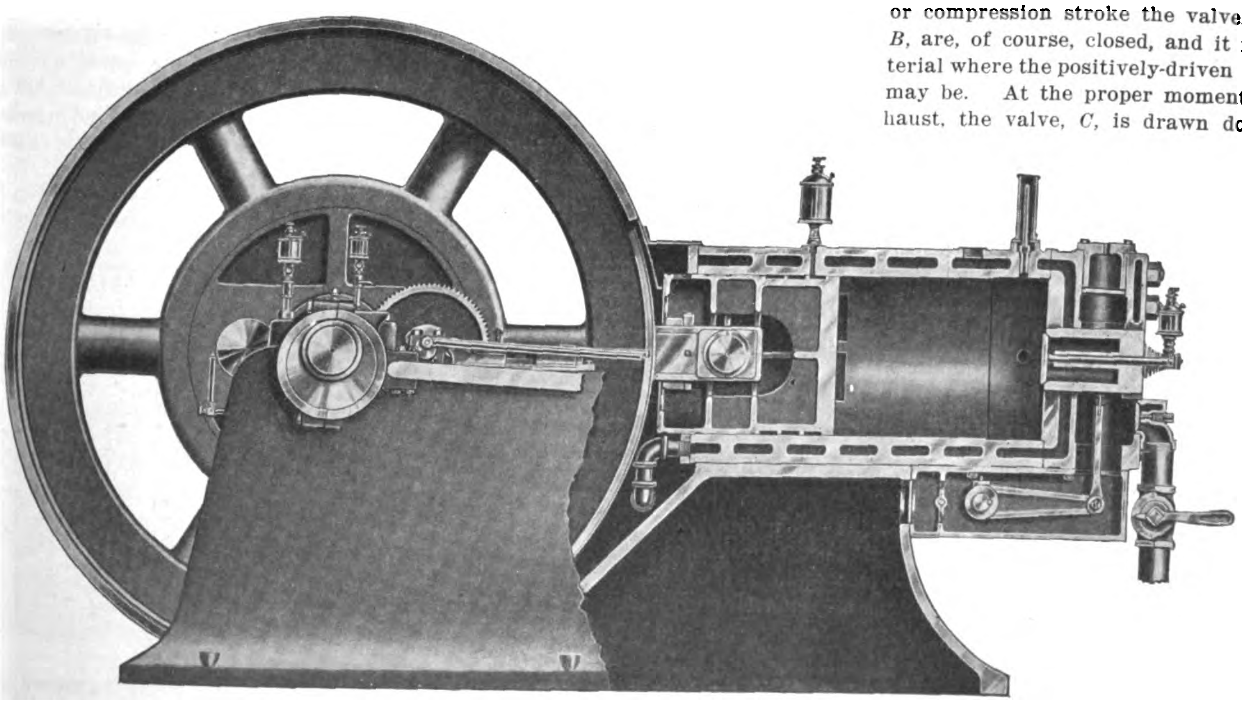


FIG. 2.—VERTICAL LONGITUDINAL SECTION OF GAS ENGINE.

The arrangement of valves is somewhat unusual. The poppet valve, *A*, Fig. 4, which is opened by means of a rocker arm, shown in the plan cross-section, Fig. 3, serves the double purpose of admitting the charge and also releasing a part of the exhaust products. Most of the burned gases pass out through an auxiliary exhaust port which is uncovered by the piston at the end of its forward stroke, as illustrated in Fig. 2. The remainder passes out at the valve, *A*, Fig. 4, and at this moment the piston valve, C, is in its lowermost position, so that the gases pass above it to the exhaust pipe. Fig. 4 shows the main piston and the valves during a charging stroke, when gas is admitted by the small poppet valve, *B*, mingling with air supplied through the air box, D, in which the rocker arm, *F*, operates, and passing beneath the piston valve, *C*, to the cylinder through the port of the poppet valve, *A*. During the return or compression stroke the valves, *A* and *B*, are, of course, closed, and it is immaterial where the positively-driven valve, *C*, may be. At the proper moment for exhaust, the valve, *C*, is drawn down low enough to connect the exhaust passage with the port of the poppet valve, *A*, and this valve is again opened, releasing that portion of the exhaust gases which did not pass out of the auxiliary port uncovered by the piston. The valves *A* and *C*, therefore, perform the double function of admission and exhaust valves.

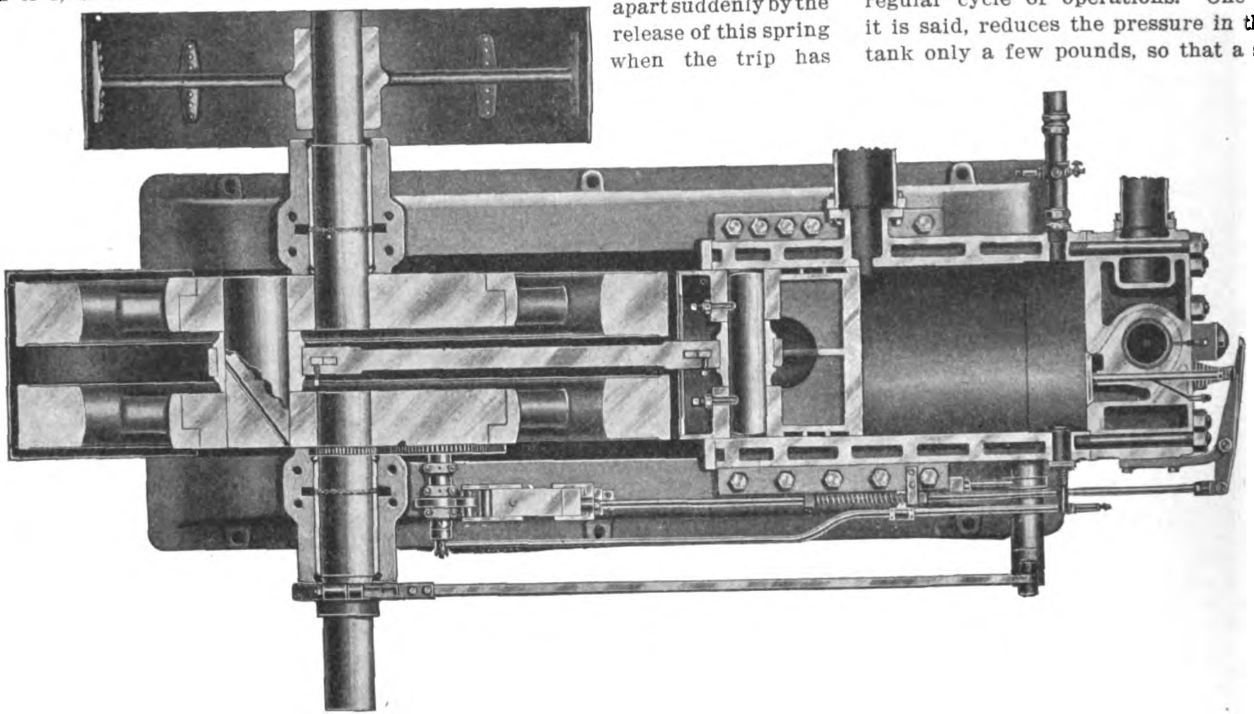


FIG. 3.—HORIZONTAL LONGITUDINAL SECTION OF GAS ENGINE.

The gas valve, *B*, is opened positively from the secondary shaft against the force of a spring as the piston starts forward on the charging stroke. The poppet valve, *A*, is opened from the same shaft, which is geared to the main shaft in the ratio of 1 to 2, as usual. The rock shaft, *E*, through which the piston valve, *C*, is driven, receives its motion, however, from an eccentric on the main shaft.

As stated above, the larger sizes of this engine are equipped with either throttling or "hit-and-miss" governors. The "hit-and-miss" governor connects and disconnects the secondary shaft to and from the main shaft. The throttling governor, shown in Fig. 5, is of the ordinary fly-ball type, arranged to control two balanced butterfly valves, one in the air inlet and the other in the gas inlet. This illustration also shows the exterior part of the electric igniting mechanism. The electric igniter is of the contact type, the movable contact within the cylinder being mounted on a spindle to the outer end of which the flat spring, shown in the engraving, is attached. The igniter spindle is rocked by a beveled trip mounted on a reciprocating rod, which receives its motion from the secondary shaft. The ignition points are tipped with iridium. The trip, coming in contact with the spring, throws the points together, and they are snapped apart suddenly by the release of this spring when the trip has passed beyond its reach. On small engines, the ordinary Bunsen tube form of igniter is provided; on larger ones, both forms are provided, so that either can be used.

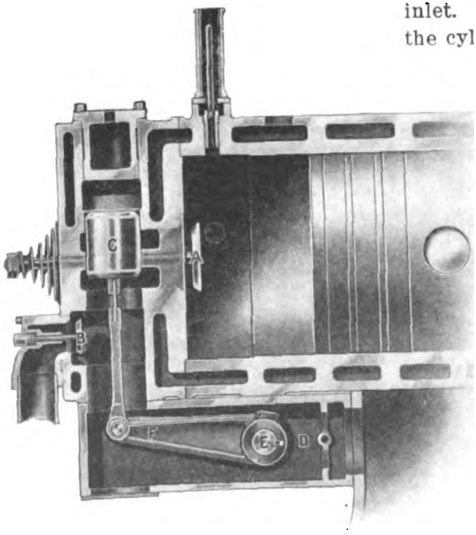


FIG. 4.—SECTION SHOWING VALVES.

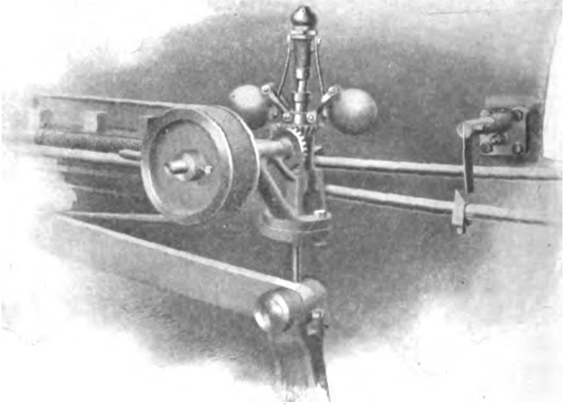


FIG. 5.—THROTTLING GOVERNOR.

The automatic starting arrangement used in connection with this engine is interesting. The arrangement consists merely of a small storage tank for compressed air, which is connected up to the cylinder of the engine through a special inlet. The pipe connecting the tank with the cylinder is provided with a small cup similar to the old-fashioned lubricator cup used on pumps and plain slide-valve engines many years ago. Before starting about a spoonful of gasoline is poured into this cup, and the gasoline is delivered into the air-delivery pipe by turning the cock. A throw of the starting valve handle then admits a small quantity of compressed air to the connecting pipe, which vaporizes the gasoline and carries it into the cylinder, where it is ignited, giving the first impulse to the piston. This impulse is sufficiently strong to carry the piston through a complete stroke, and the engine then begins its regular cycle of operations. One start, it is said, reduces the pressure in the air tank only a few pounds, so that a single filling of the tank suffices for several starts. To restore the pressure in the tank it is only necessary to shut off the gas supply from the engine, open the sealing valve between the cylinder and the pipe leading to the air tank, and raise the starting valve handle. The power stored in the fly wheels is sufficient to recharge the air tank to the desired pressure.

These engines are also built with attachment for operation with gasoline, consisting of an adjustable mixing valve and a small pump operated from the engine shaft. No atomizer or carburetor is used, the gasoline being delivered directly into the engine cylinder.

New Apparatus and Appliances

POLE-RAISING DERRICK WAGON.

The Anderson pole-raising derrick wagon shown in the accompanying illustrations was designed by W. H. Anderson & Sons, of Detroit, Mich., to expedite the planting of electric light and telephone poles, and at the same time reduce the manual labor attached thereto. The wagon, as shown, is composed of a heavy drop platform truck, upon the rear of which is placed a trunnion supporting an extension arm, or boom. This boom is made of steel tubing, in which is inserted a spar, so fitted that it can be easily adjusted to the desired height to lift poles from 35 ft. to 70 ft. in length. On the front of the wagon is mounted a hoisting winch, which operates the guy lines supporting the boom, and is so arranged that the boom can be moved to any angle even with the load in suspension. The boom is fitted with suitable tackle, which is arranged so that the wagon team of horses is enabled to raise the pole into place by means of a snatch block. The wagon also contains a tool box suitable for holding pole rings and steps, washers, and all necessary small tools needed by the pole-raising crew. The work, of course, is much speedier than by the old method of pike poles, inasmuch as the pole is suspended in such a manner that one or two men have easy control of it, and can move it in any desired direction.

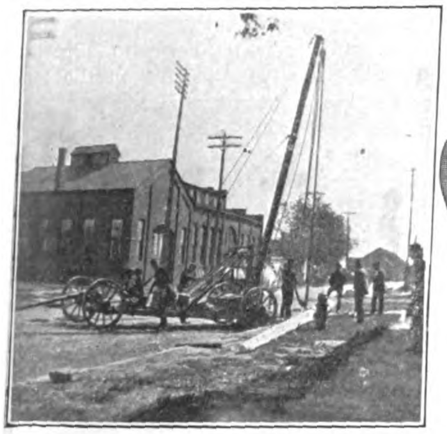


FIG. 1.—WAGON READY TO LIFT.

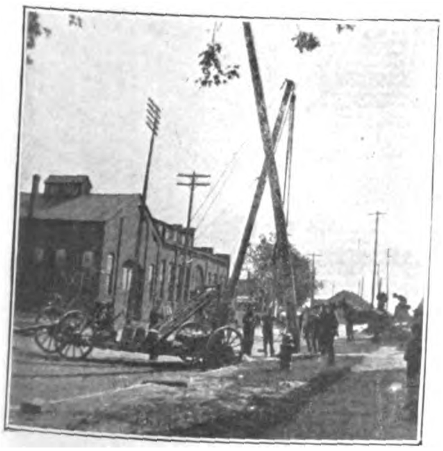


FIG. 2.—POLE PARTLY RAISED.

THE MERWARTH METALLIC GASKET.

This packing consists of a soft-metal ring brazed to a re-inforcing ring of copper, with two short pieces of soft copper wire attached to it at opposite sides to hold the gasket in position when being placed in service. Fig. 3 indicates the essential features of the packing and shows how it should be applied in order to secure perfect service. The gasket is made for 300 lbs. pressure, or below, and for each extra thousand pounds pressure an extra re-inforcing ring of copper is employed. The soft metal of the gasket, which forms the inner ring, is sufficiently ductile to adapt itself to any irregularities of surface and insure a tight joint, and being backed by the copper ring it will withstand the ordinary disturbances of expansion, contraction, vibration, etc. In the case of cylinder heads, or other large surfaces that call for frequent detachment the gasket is particularly convenient, as it can be removed and replaced without the delay and annoyance of having to clean the surfaces. The following advantages are claimed: When the bolts are once tightened the joint is complete, no retightening after a few days being necessary. The same gasket can be used over and over again, and can be put on pipes so hot that they would shrivel up a rubber gasket. The gasket is equally good for oil, acid, naphtha, ammonia, steam, water and gas. These gaskets are made by the Merwarth Metallic Gasket Company, of New York, in sizes up to 91 ins. in diameter, and besides service in their regular field they are also used for electric transformer covers.

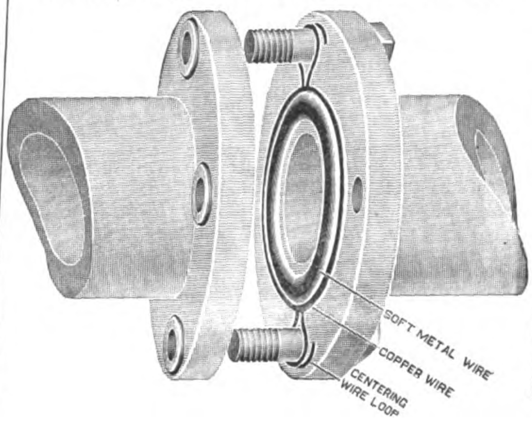


FIG. 3.—MERWARTH METALLIC PACKING.

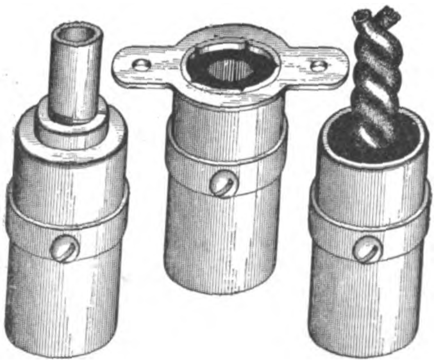


FIG. 4.—MINIATURE LAMP SOCKETS.

NEW MINIATURE LAMP SOCKET.

Fig. 4 shows three styles of the Pierce miniature incandescent lamp socket, designed and recently patented by J. D. Pierce, of Philadelphia, Pa. The socket is remarkable for its small size, the engravings being made the same size as the actual socket for candelabra Edison base lamps, and is said to have been approved for use with lamps up to 16 candlepower on 110-volt circuits by the National Underwriters' Association. The object of the inventor was to produce a socket which would be of proportionate size to the lamps used with it, and of a form suitable for decorative work and illuminated signs. The receptacle style, shown in the center engraving, may be mounted on the surface of a sign with the wires passing out underneath, or may be entirely concealed by boring a hole for it in the wood and inserting it from the rear. The socket is simple in construction, and despite its small size the work of attaching the wires is comparatively easy.

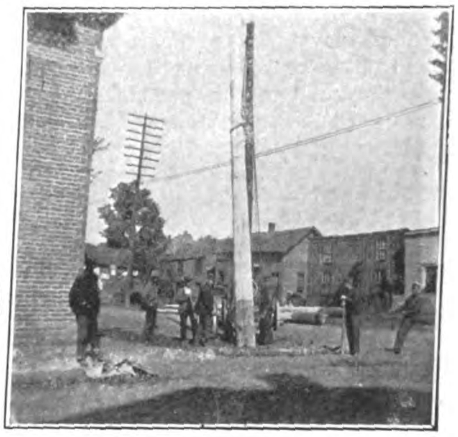


FIG. 5.—POLE READY TO BE LOWERED.

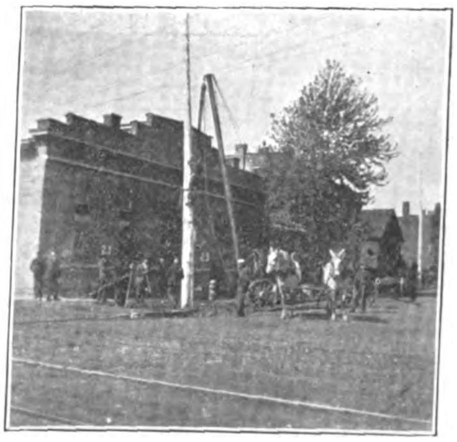
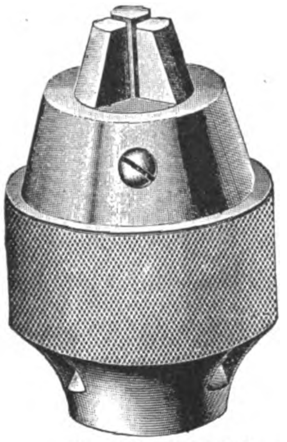


FIG. 6.—POLE IN POSITION.

SKINNER "NEW MODEL" DRILL CHUCK.

Figs. 7 and 8, herewith, show the "New Model" drill chuck made by the Skinner Chuck Company, of New Britain, Conn. The chuck is especially adapted for all light and rapid drilling, such as is done on "sensitive" drills and hand lathes. It is made entirely of steel, and of such grades as are best adapted to the different parts. Fig. 7 shows the chuck complete, and Fig. 8 shows the construction and arrangement of parts. The ring nut is threaded with a square thread of substantial pitch, which meshes with segmental threads on the backs of the three jaws. As the jaws are forced outward by the nut, they are closed upon the drill by the taper collar within which they slide. The chuck may be taken apart for cleaning and oiling by removing the three screws in the cap; but in putting it together again it is necessary to note that the number on the jaw corresponds with the number of the slot in the body of the chuck.



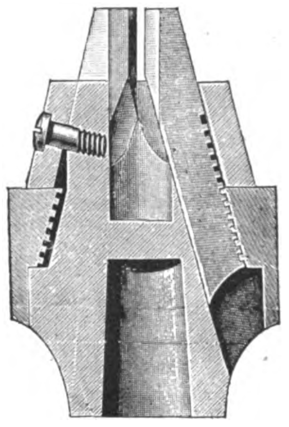


FIG. 7.—SKINNER DRILL CHUCK—FIG. 8.

The chuck is made in three sizes, and each chuck is ground true after the jaws are hardened. A spanner wrench is furnished with each chuck.

GASOLINE MOTOR.

Fig. 9, herewith, illustrates a 1¼-h.p. gasoline motor of the air-cooled type, designed by the Lowell Model Company, of Lowell, Mass., for bicycle propulsion. The motors are furnished complete with all accessories for attaching them to a bicycle. If desired, castings of this motor, or of larger sizes up to three horse-power, may be had, with blue-print working drawings for the use of those who desire to construct motors for their own use or instruction.

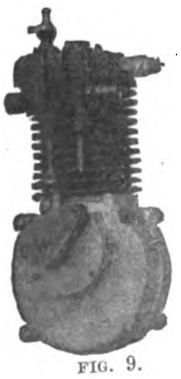


FIG. 9.

AUTOMATIC MOTOR STARTER.

The Acme solenoidal automatic motor starter, made by the Automatic Switch Company, of New York, is shown by Fig. 14, herewith. Attention is called to the method of winding the solenoid, a heavy coil being placed in series with a fine coil. When the motor is started the fine coil is short-circuited by a small switch shown at the top of the starter. This switch is opened after the resistance is completely cut out by the travel of the resistance arm, resulting in throwing the two coils in series with each other across the line. This reduces the amount of current passing through the coils and prevents the overloading of the solenoid windings. Tubular resistance is employed, and on the resistance arm graphite brushes are used, in conjunction with substantial final contacts of elastic copper adapted to carry the full-rated current of the motor. The oil chamber of the oil dash-pot governor is of such proportions as to allow a very loose fit of the plunger, avoiding the possibility of dirt or grit interfering with the proper action of the governor. Fig. 10 shows a diagram of the motor-starter connections.

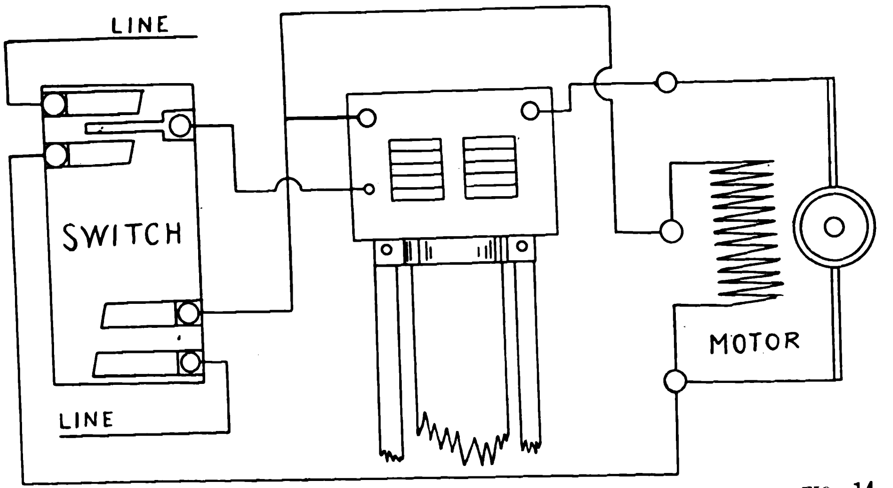


FIG. 10.—DIAGRAM OF MOTOR STARTER CONNECTIONS.

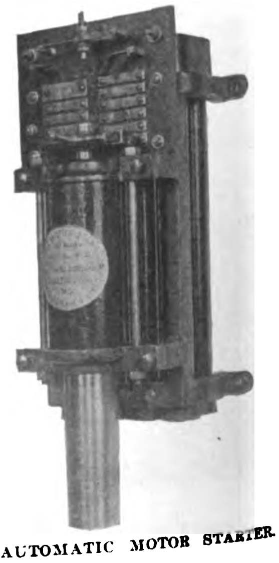


FIG. 14.—AUTOMATIC MOTOR STARTER.

ELECTRIC LIGHT REGULATOR.

A drawback of the ordinary incandescent light has been that it must be turned on full or not at all, and several "turn-down" devices have been proposed, one of the latest being that offered by the Electric Regulator Company, of New York, and illustrated herewith. Previous devices have been located in the lamp socket; the present one is not. By means of this appliance the light may be graded through five degrees. The illustrations herewith show different forms of the apparatus, one consisting of a complete portable lamp ready for connection, and two of the canopy type, which can be applied to any fixture. Fig. 13 shows a fixture adapted for use where no outlet box is installed, in which case the regulating device, which consists of a switch, resistance tube and base, all covered by a canopy, is fastened to the wall by feet. In

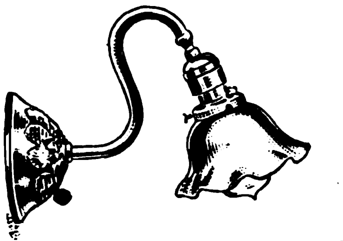


FIG. 12.—CANOPY TYPE OVER OUTLET BOX.

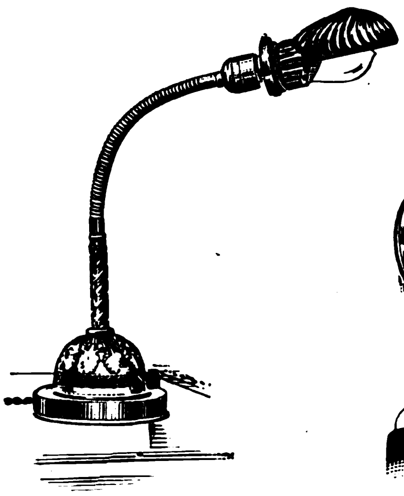


FIG. 11.—PORTABLE TYPE.

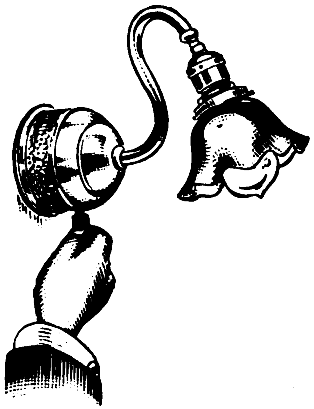


FIG. 13.—CANOPY TYPE.

Fig. 12 the feet of the device are mounted on the outlet box and the regulator is partly set into it; in either case the device is perfectly insulated and securely held in place. It is governed by a key projecting from the canopy in that type of fixture, or, in the case of a portable fixture, projecting from the base. The manufacturer draws attention to the fact that the ordinary commercial incandescent lamp is used, and that in the case of a 50-watt lamp the consumption at reduced candle-power is 32, 25, 18 and 12½ watts, respectively, corresponding to the several switch points. The device is applicable both to direct and alternating-current circuits.

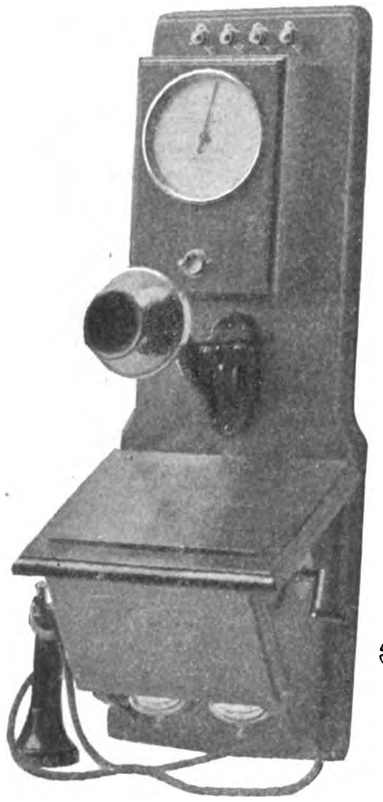


FIG. 15.—SELECTIVE TELEPHONE.

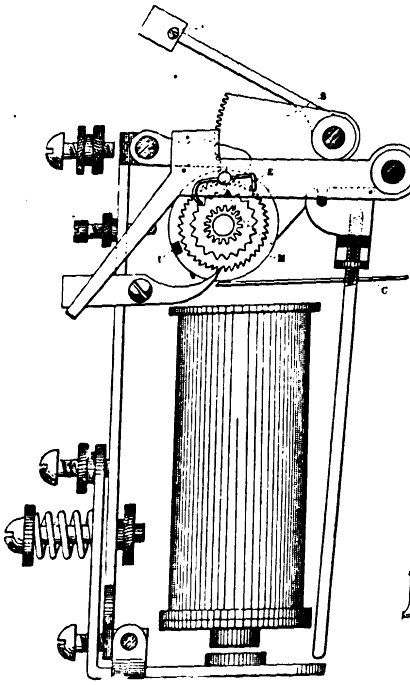


FIG. 16.—BATTERY CUT-OUT.

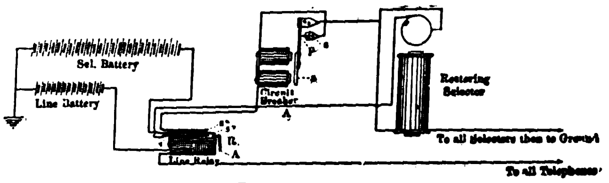


FIG. 17.—LINE CIRCUIT.

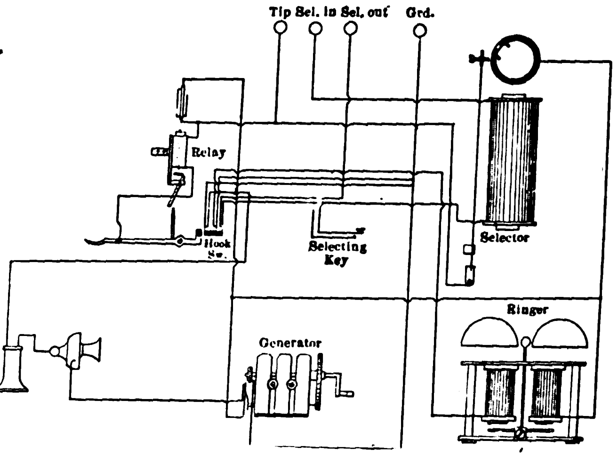


FIG. 18.—TELEPHONE CIRCUIT.

NEW FUSED SWITCHES.

A very satisfactory form of fused switch has been put on the market by the General Electric Company. As shown by Fig. 19, it consists of a combination of the well-known punched clip-spring switch, with the Edison fuse plug. It is designed for 125-volt service, and its use makes the operation of replacing a fuse a safe and simple matter, which can be performed without tools. This feature, combined with the protection which the Edison plug insures, makes this form of switch applicable in many places where other forms of switches could not well be installed. The parts are mounted on a substantial porcelain base, and the device is made with double-pole or triple-pole, single-throw switches. The fuse plugs are furnished with any capacity up to and including 30 amperes.

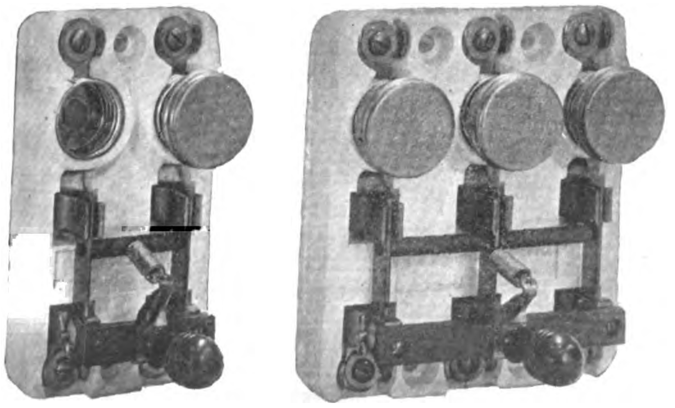


FIG. 19.—FUSED SWITCHES.

SELECTIVE LOCK-OUT PARTY-LINE SYSTEM.

Figs. 15 to 18 show various parts of an automatic selective lock-out party-line system which has been brought out by the United States Electric Manufacturing Company, of Butler, Pa. The system can be applied to any telephone exchange board, and is especially adapted to farmers' lines, as any number of telephones up to 35 can be operated on one line. Fig. 17 shows the line circuit, Fig. 18 the telephone circuit, and Fig. 16 the automatic battery cut-out. The system operates as follows: In removing the receiver from its hook (Fig. 18) a wiping contact is made, grounding the tip of the line and causing the line relay (Fig. 17) to close its armature. This connects the selector battery through the circuit-breaker and also closes the telephone circuit at the relay (Fig. 18), which in turn holds the line relay after the wiping contact is broken. The selector battery is now open at the selecting key (Fig. 18); when this is closed it operates the circuit-breaker, which stops all selectors on the line when the station desired is reached. To obtain the station desired, it is only necessary to press the key shown in Fig. 15 and watch the dial as it revolves, one point at a time; when it is opposite the number desired, release the key and ring up the desired party in the ordinary manner. Hanging up the receiver disconnects the line battery; the line relay armature then drops back, throwing the selector battery direct on the line and restoring the same to its normal condition. The automatic battery cut-out, shown by Fig. 16, works as follows: When the telephone is not in use the insulated point, *I*, rests on the spring, *C*, which opens the selector battery at that point; when a station is being selected, the point, *I*, is caused to move around and an electric contact is made between the disk, *M*, and the spring, *C*. When the restoring battery is thrown on the line, the disk, *M*, is restored to its normal position, its motion being retarded by an escapement, *E*, for the purpose of giving the telephone selectors sufficient time to be restored before the battery is cut out. The telephones are worked on the central-energy plan, and the system is said to give immunity from interference when talking, rendering the telephonic conversation secret.

HIGH-TENSION ARC-LIGHT CUT-OUT.

Fig. 19, herewith, shows a high-tension arc-light cut-out, made by Eugene B. Abbott, of Cleveland, Ohio, and built to operate one to fifty arc lamps. The box is of cast iron, having a close-fitting hinged cover so as to protect the contacts and working parts from dust and water. The contact blades are machined, and, having a sleeve contact, the surfaces are always kept clean. The contacts and terminals are mounted on a single piece of porcelain, and from Fig. 19, which shows the cut-out with the current on, it will be seen that the contacts are so designed that there is always a part of the metal in contact, both on the main line to be short-circuited, and on the lamp circuit to be opened, thus preventing sparking at the contacts. When lamps are switched into circuit, the connections to them are made before the line is thrown in, of course. The throw is said to be instantaneous, and is carried beyond the dead center by a spring. The cut-out is constructed so as to lead the current along lines of least resistance and away from the points of arcing before the circuit is broken.

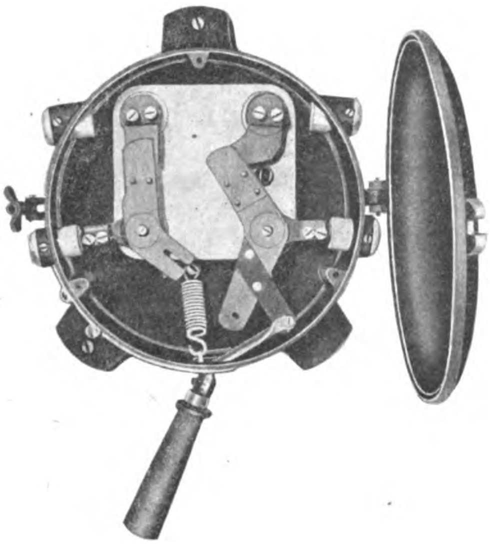


FIG. 20.—ARC LIGHT CUT-OUT.

"HUB DOME" ELECTRIC BELL.

Fig. 21, herewith, represents a new electric bell recently brought out by the Holtzer-Cabot Electric Company, of Boston, Mass., and designated the "Hub Dome." It embodies some features in its construction which are unique. The shell bridge and supporting legs are pressed from one sheet of steel. A small area of metal is drawn inward at the hole for the threaded supporting stem, thus giving a long surface for the thread, the surrounding metal being hardened in the operation. In this way a secure fastening is accorded the bell. The frame supporting the magnets and all portions of the inner mechanism that are liable to rust are of copper. The bell measures 2½ ins. in diameter, and adjustment is effected by means of a screw and lock-nut.

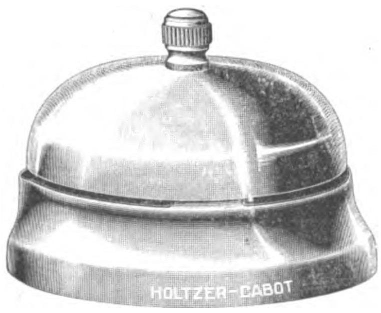


FIG. 21.—"HUB DOME" BELL.

NEW LAMP ADJUSTER.

The Morse automatic incandescent lamp-cord adjuster, and the Webster angle adjuster and reflector, are shown by Fig. 22. Both devices are made by the Incandescent Electric Light Manipulator Company, of Boston, Mass. The former works on the same principle as the well-known Hartshorn window-shade roller, enabling one to raise or lower a suspended lamp as one would a window shade. The case is made of imitation hard rubber, is a non-conductor, and is 2¼ ins. in diameter. By the use of the angle adjuster and reflector the lamp may be hung at any angle in a range of 180°, and the light reflected at that angle. The illustration exemplifies the method of application, showing both devices in use over a stitching machine.

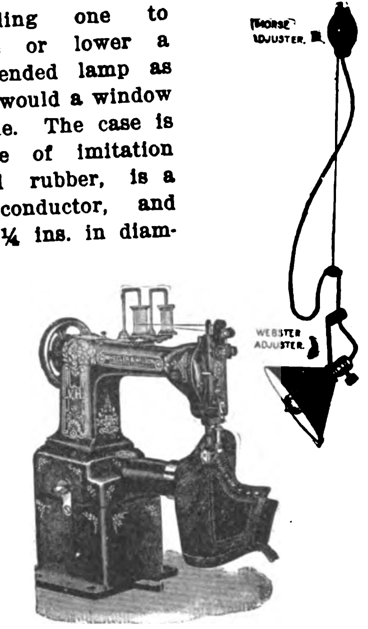


FIG. 22.—LAMP ADJUSTER.

EAGLE PIPE WRENCH.

A tool which is simplicity itself in both application and manufacture, is the Eagle pipe wrench, made by the Frank Mossberg Company, of Attleboro, Mass. It is designed for the same service as that performed by the more costly and complicated wrenches hitherto made, and is made from steel forgings, hardened and warranted. The wrench obviously requires absolutely no adjustment, and it is said to have a positive grip. It will take any size of pipe, nut or bolt, from ⅛ in. to ¾ in. in diameter, and is adapted to a multiplicity of purposes. It might be supposed at first glance that it would be necessary to hold the wrench tightly in the palm of the hand when turning, but such is not the case; the shorter jaw naturally tends to approach the longer jaw, and grips any intervening object tightly. Its very simplicity and ease of application will doubtless commend it to machinists, pipe fitters, tool makers and others who use a pipe wrench.

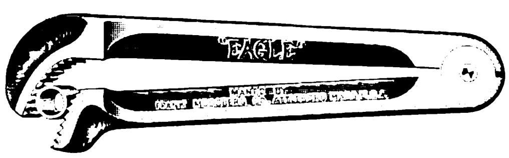


FIG. 23.—EAGLE PIPE WRENCH.

THE G-D TROLLEY WIRE "PICK-UP."

When a trolley wire breaks it is almost invariably at one of the most inconvenient points on the line, and one which requires the greatest length of time for the repair wagon to reach the scene of the accident, so that a trolley car crew is usually confronted with the alternatives of using coats or other articles of apparel for insulating wrappings in order to pick up the broken wire and hang it out of reach, or leaving it in the road to become a probable source of law-suits. With a view to meeting such exigencies, the Garton-Daniels Company, Keokuk, Ia., has devised and put on the market the extremely simple trolley wire "pick-up" or tongs illustrated herewith. The device consists of a simple pair of wooden tongs, the short jaws of which are provided with transverse grooves for gripping the trolley wire and preventing it from slipping out of the crotch of the jaws when the long ends are drawn together. The tongs are made of thoroughly-seasoned straight-grain oak, and provided with a straining rope attached to one handle and passing through the other. When the wire is picked up, the free end of this rope is thrown over a cross-arm or tree, enabling the employees to hoist the broken end of the trolley wire out of reach until it can be properly repaired. Fig. 24, herewith, shows the tongs with the end of a wire between the jaws ready for hoisting; Fig. 25 shows the tongs and trolley wire hoisted up into the air by the rope.

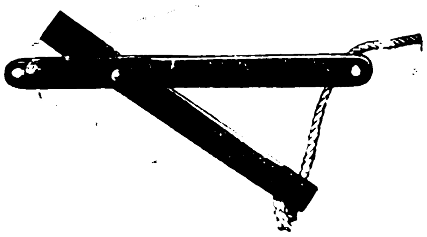


FIG. 24.—TROLLEY WIRE "PICK UP."

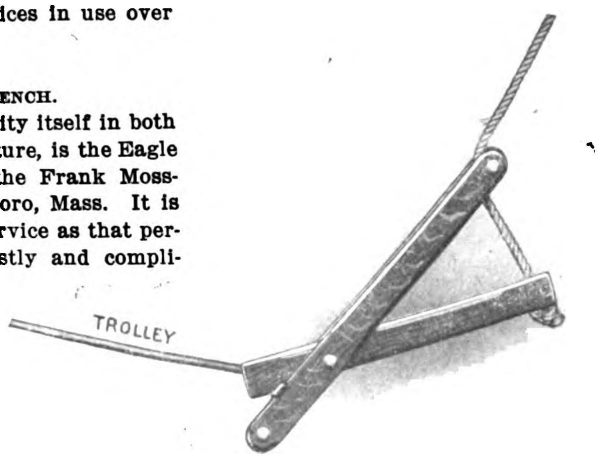


FIG. 25.—TROLLEY WIRE "PICK UP."

NEW BOOKS.

Wireless Telegraphy. (Second Edition). By G. W. de Tunzelmann. London: Published by *Knowledge*. Cloth; 104 + iv pages, 5 x 7 ins.; 30 illustrations. Price, 1s. 6d. In the United States, 50 cents.

As a semi-popular exposition of the Marconi system, devoid of hysterical generalities and sensational "predictions," this little book is a conspicuous success. The author describes the system simply and plainly, explains in every-day English the general principles of its operation, and closes with some judicious remarks concerning the other workers in the field of space telegraphy, namely, Lodge, Popoff, Slaby and Fessenden.

Practical Calculation of Dynamo-Electric Machines. (Second Edition). By Alfred E. Wiener. New York: Electrical World and Engineer (Inc.). Cloth; 727 + xxxvi pages, 6 x 9 ins.; 381 illustrations; 76 tables. Price, $3.00.

In this edition of his well known book Mr. Wiener has included some extremely valuable tables of data relating to insulated magnet wires and dimensions of standard modern dynamos. The bulk of the book, which constituted the first edition, has been revised and considerably expanded. It is to be regretted, however, that the author still adheres to the fallacy that the lines of force entering the teeth of a slotted armature do not contribute to the production of e.m.f. and are therefore to be classed as leakage. This was experimentally proved untrue several years ago. It is also regrettable that in the practical examples of dynamo calculation the obsolete types were not discarded and more examples of modern types added.

Electrical Engineering Testing. By G. D. Aspinall Parr. Philadelphia: J. B. Lippincott Company. Cloth; 473 + viii pages, 5½ ins. x 8½ ins.; 218 illustrations; 31 tables. Price, $3.50.

This is an excellent reference book in many respects. It contains fundamental directions for making 128 tests; valuable suggestions as to the practical splicing of electric cables; an appendix comprising proofs of formulas, solutions of inferences and descriptions of apparatus; and a closing section consisting of a most useful set of tables and aggregation of basic data. Notable among the tables are one for photometer scales, one of common logarithms of four places up to 10,000, and one of doubled square roots. The subject matter is very much condensed, this being necessitated by the scope of the book, but it is in the main entirely clear in statement. The diagrams are excellent for the most part, but the majority of the illustrations of instruments are very poor, some being so bad as to be useless and irritating to the reader. The book has been written apparently for English readers, so that American engineers will need to translate units of measurement in many cases, and American instruments are not even mentioned. This, however, affects only a very small proportion of the total contents of the book.

THE ABENDROTH & ROOT COMPANY'S NEW WORKS.

After a serious interruption, due to the almost total destruction of its large works in Brooklyn, N. Y., by fire last July, the Abendroth & Root Manufacturing Company has resumed the manufacture of its well-known spiral riveted pipe and water-tube boilers, with new works at Newburgh, N. Y., having purchased the recently built plant of the Wright Steam Engine Works. At the time of the fire, the factory in Brooklyn had been for months running night and day shifts, and contracts had been taken which would have kept every department filled for the remainder of the year. Twenty large special machines were wrecked, and hundreds of tons of raw material and partially manufactured goods were converted into scrap. Seven miles of pipe for one purchaser, made up and ready to ship, were destroyed. The Newburgh plant is a model one, and covers twelve acres of land, with a frontage of 823 ft. on the Hudson river and a private dock extending out to deep water. The buildings are entirely of brick, substantial in construction and imposing in appearance.

As the purchase of the Newburgh property included the entire equipment of machinery, patterns, stock and good-will of the Wright works, in which were built the well-known Dixon-Corliss, the Wright and the Payne high-speed engines, the Abendroth & Root Manufacturing Company is also prepared to execute orders for these engines or for repair parts for those already in use.

PERSONAL.

MR. W. E. LEWIS has been elected president of the Utica Electric Light & Power Company, Utica, N. Y.

MR. GEO. A. WADDELL, of Baltimore, Md., has been appointed chief electrician for The Merchants and Miners Transportation Company, with offices in Baltimore.

MR. CHAS. L. SMITH, superintendent of the Findlay (Ohio) Street Railway Company, has been appointed general manager of the Toledo, Bowling Green & Southern Traction Company.

MR. R. S. MASSON has resigned the position of superintendent of the Independent Electric Light & Power Company, San Francisco, in order to engage in consulting electrical engineering.

MR. LAMAR LYNDON, consulting electrical engineer, has returned from a trip to the West Indies, whither he went in December in order to investigate and make a report on an electric railway plant.

PROF. W. E. GOLDSBOROUGH, of Purdue University, has been appointed chief of the department of electricity of the Louisiana Purchase Exposition, to be held in St. Louis during the summer of 1903.

MR. G. W. NEWCOMER, who was formerly connected with the United States Carbon Company, has been appointed southern representative of the Commercial Electrical Supply Company, St. Louis, Mo., with headquarters at Memphis, Tenn.

MR. JOHN L. LIVERS has resigned his position of superintendent and electrician of the Electric Light & Power Company at Harper's Ferry, W. Va., to accept a similar position with the Chesapeake & Potomac Telephone Company, with headquarters at Cumberland, Md.

MR. GAYLORD THOMPSON, general manager of the New Castle Electric Company, New Castle Traction Company, and Lawrence Gas Company, has been elected secretary and treasurer of these companies, to succeed Mr. E. E. Hamilton, who recently resigned this position.

MR. J. J. NATE has resigned the position of general superintendent of the Standard Telephone & Electric Company, Madison, Wis., which he has held for some time past, in order to accept a responsible position on the staff of the Stromberg-Carlson Telephone Manufacturing Company, Chicago.

MR. MERRILL H. FISHER has leased the Alamagordo (New Mexico) electric light plant, and will make a number of enlargements and improvements in the plant. Mr. Fisher advises us that he will be glad to receive catalogues, price lists and other advertising literature from manufacturers of electrical apparatus.

MR. HARTLEY GISBORNE, having removed to Ladysmith, Vancouver Island, has resigned the Secretaryship for Canada of the Institution of Electrical Engineers, London, England. The Council of the Institution has appointed Professor R. B. Owens, of McGill University, Montreal, to succeed Mr. Gisborne.

MR. J. B. OLSON has been appointed general sales manager for the India Rubber & Gutta Percha Insulating Company, recently made vacant by the tragic and widely lamented death of Mr. Jas. W. Godfrey, which was mentioned in this column. Mr. Olson's appointment was a thoroughly deserved promotion, as well as a case of logical succession.

MR. GEO. A. DAMON, managing engineer of the Arnold Electric Power Station Company, Chicago, on January 10 delivered, before the engineering students of the University of Illinois, an extremely interesting and able lecture on "How a Power Station Is Designed." It would be difficult to find an engineer better qualified than Mr. Damon to discuss this topic.

DR. N. S. KEITH, the well-known electrical engineer and pioneer in the electrical industry, who has for several years made his headquarters on the Pacific Coast, recently established offices at 95 Liberty Street, New York, where he will practice consulting engineering. Dr. Keith will be heartily welcomed back in this section, where he is as well known as in California.

MR. W. R. MASON, who has made a host of friends as representative successively of the Walker, Siemens & Halske, and Stanley companies in St. Louis, during the past several years, has accepted a position on the staff of the Chicago office of the Sprague Electric Company. Mr. Mason has had long experience in electrical work, having been connected for some time with the original Sprague Electric Motor Company.

MR. FRANK H. TAYLOR, who has been fourth vice-president of the Westinghouse Electric Manufacturing Company since 1897, was elected second vice-president at a meeting of the directors of the company, held in New York January 23, to succeed Mr. B. H. Warren, resigned. Mr. Warren still retains his connection with the company as a director. Mr. Taylor is succeeded in the fourth vice-presidency by Mr. L. A. Osborne, who heretofore has been manager of the works.

MR. M. W. THOMAS, for many years connected with the sales department of the Fort Wayne Electric Company, was recently appointed sales engineer for the electrical machinery department of the Michigan Electric Company, Detroit, Mich. This appointment calls forth congratulations to both the company and Mr. Thomas; there are few men in the commercial branch of electrical work who have so wide and warm an acquaintanceship as Mr. Thomas, and who have been so uniformly successful in their line of work.

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TRADE PUBLICATIONS.

MIETZ & WEISS GAS AND OIL ENGINES. August Mietz, New York.—The 1902 catalogue of this well-known engine, which, as the title of the catalogue indicates, is built for use with either gas or kerosene oil as fuel.

STEAM AND OIL SEPARATORS. John T. Lindstrom, Allentown, Pa.—An illustrated catalogue containing a detailed description of the Lindstrom separator; a description of this appliance was published in our January number.

ELECTRICAL DATA. Chase-Shawmut Company, Boston, Mass.—A catalogue containing tables and diagrams which will be found convenient for reference by practical workers in the wiring and installation departments of any central station.

CALENDAR. The Holtzer-Cabot Electric Company, Boston, Mass.—A calendar pad of the usual form, consisting of monthly leaves mounted on a cardboard backing. The upper portion of the card bears a very clear-cut picture of the Holtzer-Cabot factory at Brookline, Mass.

RENOLD SILENT CHAIN GEAR. The Link-Belt Engineering Company, Philadelphia.—A pocket-size pamphlet devoted to this well-known chain gear. The pamphlet contains illustrations showing the application of the chain, and a number of installations where it is used.

LEATHERINE. Chas. A. Schieren & Co., New York.—A folder setting forth the merits claimed for leatherine, which is a belt dressing designed to prevent slipping of belts and to add to the life of the belt. It is stated that this preparation makes a belt absolutely weather-proof, and protects it from acid, dyes, etc.

MAGNETIC SEPARATORS. General Electric Company.—This is Bulletin No. 4274, containing illustrations and a description of the magnetic separator built by this company. The mechanism of the apparatus requires only ⅛ horse-power for driving and the electromagnet which performs the separation requires about 75 watts.

AUTOMOBILE APPLIANCES. The Mason Regulator Company, Boston, Mass.—A pocket-size pamphlet, handsomely executed, and containing illustrated descriptions of the Mason steam automobile engine and its parts, throttle valves, burner regulators, by-pass regulators, check valves, needle valves, oil cups, and ejectors for steam automobiles.

WHY ARE INSTRUMENTS NECESSARY? The Shelby Electric Company, Shelby, Ohio.—A little pamphlet containing some common-sense arguments as to methods of selecting incandescent lamps. The pamphlet points out that the practical way to compare lamps is to note their illuminating ability by looking at the object lighted and not at the lamp itself.

AMERICAN SEPARATORS. The Whitlock Coil Pipe Company, Hartford, Conn.—A pocket-size pamphlet, handsomely executed, and containing a complete description of the American separator, together with some cogent remarks concerning wet steam as a source of waste. The pamphlet also contains an illustration and description of the American exhaust head.

VEST-POCKET MEMORANDUM CALENDAR. John A. Roebling's Sons Co., New York.—This is an extremely neat and useful little remembrance, consisting of a Russian leather book cover and a set of calendar pads, one pad for each month of the year, and each pad containing a dated blank page for each day in the month. The pads are easily removable from the leather back for interchanging.

CALENDAR. Fort Wayne Electric Works, Fort Wayne, Ind.—A card containing a calendar for the month of January, a picture of a Fort Wayne direct-current generator and the name and address of the company on its obverse side, and a calendar for the year and a list of the company's sales offices on the reverse side. The design on the front of the card is very handsome, the characters being executed to give a bas-relief effect.

CALENDAR. The George F. Brunt Porcelain Works, East Liverpool, Ohio.—This is a large calendar card 20 x 24 ins., containing in the center an exquisitely executed representation of Ophelia, 13 x 19 ins., on each side of which is printed one-half of the calendar for the year. This souvenir is by far the most handsome of the lot that the new year has thus far brought to the reviewer's desk. The calendar, however, is superfluous, as the picture completely monopolizes the attention of all observers.

TERSE TELEPHONE TALK. Kellogg Switchboard & Supply Company, Chicago.—This is a handsome brochure, the mission of which is clearly indicated by the original title given to it. The book reflects on each page the progressive spirit of the Kellogg Company, and will be found extremely attractive by anyone connected with the telephone industry. It contains a great deal of interesting information concerning the history of the independent telephone movement, and also some practical information relating to Kellogg apparatus.

DIRECT-CURRENT DYNAMOS AND MOTORS. The Robbins & Myers Company, Springfield, Ohio.—Circular No. 21, containing an illustrated description of the Robbins & Myers' protected type of dynamo and motor. This machine, as most of the electrical trade are aware, is almost entirely enclosed, only the commutator and brushes being exposed, and a small aperture being left at the pulley end of the machine for ventilation. The machines are built in sizes ranging from ¼ horse-power to 12½ horse-power in motors, and ¼ kilowatt to 10 kilowatts in dynamos.

◆

BUSINESS NEWS.

WILLIAM ROCHE, of New York, manufacturer of the well-known Standard dry battery, reports much success with the new Standard electric flashlight which he recently put on the market, and which was described in the November issue of this paper.

THE HOLTZER-CABOT ELECTRIC COMPANY has established a New York office at 143 Liberty Street, which has been placed in charge of Mr. H. J. Brewer. The New York trade will undoubtedly welcome the re-establishment of a Holtzer-Cabot office in this city.

THE R. THOMAS & SONS COMPANY, East Liverpool, Ohio, announces that its suit against F. M. Locke for infringement of J. W. Boch's patent No. 600,475, for glazed filled porcelain insulators has been decided in its favor, and a decree for injunction against Mr. Locke has been granted.

MARSHALL-SANDERS COMPANY, Boston, Mass., reports a most gratifying demand for its Midget plug and receptacle, and Dow cord adjuster. The plug and receptacle were described in a recent issue of this paper, and the Dow cord adjuster is too well known to the electrical trade to require any description.

CENTRAL ELECTRIC COMPANY, Chicago, calls the attention of the trade to the fact that it carries a full stock of I. X. L. weatherproof, slow-burning and combined slow-burning and weatherproof line wires; office, annunciator and magnet wires; galvanized telephone wire, and last, but by no means least, Okonite insulated wires and cables.

FREE SCHOLARSHIPS.—Through the generosity of the founders of the American School of Correspondence, Boston, and of several prominent manufacturers, the trustees of the school are able to offer each year a few free scholarships in engineering courses to worthy and energetic young men. The scholarships for 1902 are now available, and applications will be considered from readers of the AMERICAN ELECTRICIAN.

WALTER L. FLOWER & CO., St. Louis, Mo., report that the demand for Acme oil filters during the past sixty days has been the greatest since the firm has been in business. They have exported to Japan

A COMMUTATOR NECESSITY.

GALES
COMMUTATOR COMPOUND.
DIRECTIONS FOR USE
SEE THAT YOUR COMPOUND

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name...
Address...
A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO

within that period 22 of these filters, this order being obtained through one of the large oil refining companies. The same company also placed with Messrs. Flower & Co. orders for twelve filters for the United States.

FRED M. LOCKE, Victor, N. Y., announces that his insulator manufacturing plant, which was nearly destroyed by fire on January 5, is now in course of reconstruction, and that he will be in a position to fill orders promptly on March 1. When the factory has been rebuilt, its facilities will be much superior to those of the old factory. Mr. Locke has on hand a stock of various sizes of porcelain insulators, from which small orders can be filled pending the completion of the new factory.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., states that on account of the extremely gratifying success which it has had in the sale of Emerson alternating-current fan motors and Peerless direct-current fan motors, it is making arrangements for earlier contracts this year than hitherto, in order to be sure of taking care of the trade. Last year its entire output was sold before the first of June. A large number of contracts have been closed thus far this year.

A ROYAL GOOD TIME.—The Michigan Electric Company, Detroit, Mich., recently gave the first of a series of projected annual dinners at the Russell House, Detroit, to its fifty-two employees, and the affair was highly enjoyable. The banquet was followed by an entertainment supplied by well-known vaudeville artists, and at the close of the affair it would have been difficult to find anywhere in the trade a more thoroughly gratified and satisfied set of employees than those of the Michigan company.

PITTSBURG BOILER SCALE RESOLVENT COMPANY, Pittsburg, Pa., recently received an order from the United States Government for 1000 lbs. of boiler compound to be shipped to the Philippine Islands, for use in the boiler plant of the Government ice works at the Military Hospital, Iloilo, where the water is highly impregnated with lime and salt. This is the second order that this company has received from the Government for boiler compound to be shipped to the Philippine Islands within the past year.

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y., reports the receipt of an order from the British Westinghouse Electric & Manufacturing Company for 60 of its "New Process" noiseless pinions for the equipment of the British company's new plant. These pinions are to be used on motors for driving machine tools, electric cranes, etc., and will transmit from 5 to 40 horse-power each. Orders from other sources are coming in fast, and the outlook is promising for a good business year.

STAINOFF.—One of the most useful preparations that has been brought out for some time is called "Stainoff," which is prepared by the D. M. Steward Manufacturing Company, Chattanooga, Tenn., the well-known manufacturers of lava insulators. Stainoff is put up in stick form, and is designed to remove from the skin all stains due to ink, paint, grease, rust, etc. The material does not roughen the skin like pumice stone, and tends to keep the hands white and soft. Its efficacy as to ink stains has been tested in this office and found to be all that is claimed for it.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, manufacturer of the well-known Schmidt telephone instruments and apparatus, has removed its New York office from 325 Broadway to 395 Broadway, where much better facilities will be enjoyed for handling the rapidly increasing business of the company. The intrinsic merit of this company's apparatus is gradually but firmly claiming recognition at the hands of jobbers and telephone users, and as a result the company's business shows an enormous increase during the past year over previous years.

THE AMERICAN ELECTRIC FUSE COMPANY has opened at Atlanta, Ga., a branch office and stock rooms, where a complete line of fuse-wire, fuses, lightning arresters, Rolfe protectors, wire joints, and other American Electric specialties will be carried for the convenience of trade in the South. The Southern office will be in charge of Mr. Price E. Allison, who has for several years been one of the traveling representatives of the company. Mr. Frank G. Jones, president of the American Electric Fuse Company, reports the company's business for the year 1901 to have been three times that for the preceding year.

ARROW BOILER COMPOUND.—The Arrow Boiler Compound Company, St. Louis,

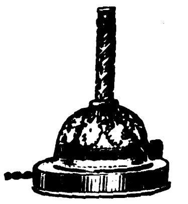
**Telephone
The
Time-Saver.**

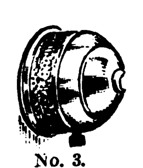
**In Manhattan:
Business Service
from $5 a month.
Residence Service
from $4 a month.**

New York Telephone Co.
15 Dey St. 111 West 38th St.
215 West 125th St.

THE BYESVILLE GLASS and LAMP CO., Byesville, Ohio.
Manufacturers of
Arc Light and Incandescent Globes and Shades
OF ALL DESCRIPTIONS,
SEND FOR OUR PRICES.

THE SAYLES Electric Light Regulator


No. 2.
Base of Portable.


No. 3.
Where Outlet
Box is not used.

No. 4.
Where outlet
box is used.

Descriptive Catalogue and Price List mailed on application .˙. .˙.

Saves substantially one-third, one-half, two-thirds and three-fourths of the current, as shown by the certificate of official test by the New York Edison Company.

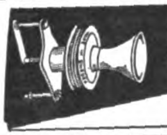
Regular lamps only required, supplied by all lighting companies as part of lighting contract.

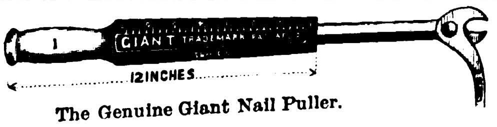
No Extra Expense for Special Lamps.
APPROVED BY THE UNDERWRITERS.

Electric Regulator Company, 136 LIBERTY ST., NEW YORK.

HARE'S
COMMUTATOR
COMPOUND

BIG STICK, 35 CENTS.
Sample Free.
SOUTHWORTH & HARE,
Indianapolis, Ind.


GENUINE ERICSSON
SWEDISH COAL-
GRAIN.
MICROPHONE
THE PERFECT TRANSMITTER.
No Packing. No Adjusting.
No Trouble. - Also Complete Line
Long Distance Telephones.
Ericsson Telephone Company, 296 Broadway, N.Y.



The Genuine Giant Nail Puller.

SMITH & HEMENWAY CO.,
Mfrs. of Hardware Specialties.
Ask your dealer for these goods.

SEE the GREEN BOOK of Hardware Specialties about the Genuine Giant Nail Puller. It tells of only the best. Is the best too good for you?

Utica Drop Forge & Tool Co.,
Mfrs. of Largest Line Nippers and Pliers in the World.
296 BROADWAY, NEW YORK CITY.

PLATINUM
PLATINUM FOR CONTACT POINTS IN ELECTRICAL INSTRUMENTS.
PLATINUM FOR TELEPHONES. PLATINUM FOR ELECTRICAL INSTRUMENTS.
We sell PLATINUM in any quantity, either large or small. We buy PLATINUM, or anything containing PLATINUM, in any quantity.

FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.
BAKER & CO.
MANUFACTURERS OF PLATINUM IN ALL SHAPES.
Newark, N. J. New York Office, 120 Liberty St.

Mo., calls the attention of boiler users to the fact that its compound is put up according to 22 different formulas, the particular formula to be used depending upon the character of the scale formed. It is necessary, therefore, before ordering Arrow compound, to give the company an opportunity to test a sample of the scale which has been formed in the boiler. This compound, it is stated, does not contain caustic soda, potash, or anything injurious to boiler material, and does its work rather differently from most others. It does not dissolve the scale, it is said, but is forced through it, and the scale then drops off in its original layers, but in a very brittle condition.

THE BURT MANUFACTURING COMPANY, of Akron, Ohio, announces recent orders for very large Cross oil filters from the Government Printing Office at Washington, McIntosh, Seymour & Co., Auburn, N. Y., and the De Beers Consolidated Mining Company, Ltd., of Kimberley, South Africa.

ELECTION OF OFFICERS.—At a meeting of the directors of the Potomac Terra Cotta Company, Washington, D. C., last month, the following officers were elected: Harry B. Mason, president; G. E. Mason, vice-president; G. Y. At Lee, secretary and treasurer. The company reports that business was never in a better condition than at the present time, the orders already on hand covering enough conduits for future delivery to keep the factory running at full force for several months to come.

THE WILLIAM B. PIERCE COMPANY, Buffalo, N. Y., report a flourishing trade in Dean boiler-tube cleaners. This cleaner is claimed by the manufacturer to be the only one that will clean both the inside and outside of a boiler tube. The manufacturer states that this cleaner is used by the General Electric Company at its Schenectady and Harrison Works; South Bend Electric Company, South Bend, Ind.; United Traction Company, Albany, N. Y.; Brooklyn Rapid Transit Company, Brooklyn, N. Y.; Springfield Street Railway Company, Springfield, Mass.; Carnegie Steel Company, and the Standard Oil Company, the last-mentioned company having just placed an order for its thirty-fifth machine. The machine is furnished free on ten days trial.

PENNSYLVANIA ELECTRICAL AND RAILWAY SUPPLY COMPANY, Pittsburg, Pa., has recently enlarged its factory considerably, and is now in a position to do repair work and other machine work with the utmost promptness. The company has special facilities for building new commutators and refilling old ones, rewinding field magnet coils, building or repairing brush-holders, and other pieces of electrical apparatus. The company is general agent for the armature coils made by the Pittsburg Armature Works, and is also general agent for a portable primary battery which is said to be the only one capable of giving four candle-power for twelve hours with reliability, and at a cost of five cents. The Columbia incandescent lamp is also one of its prominent specialties.

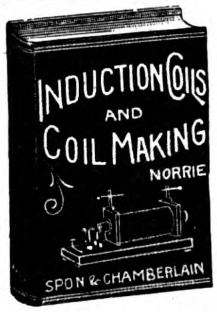
WESTINGHOUSE, CHURCH, KERR & Co. report sales during the last month which include several interesting stoker, mechanical-draft and economizer equipments. The New York office reports an order for two 100-in. 24-grate stokers to Obermeyer & Leibman, of Brooklyn; a complete stoker and economizer plant, with stack and mechanical draft, to the Union Bag and Paper Company, of Sandy Hill, N. Y.; two 138-in. 24-grate and four 132-in. 22-grate stokers to the British Westinghouse Electric & Manufacturing Company at Manchester, England. The Boston office reported the sale of an equipment of dampers and actuating mechanism for economizers for the Rockingham County Light & Power Company at Portsmouth, N. H., and the Detroit office three 54-in. 20-grate stokers for the Washington Arcade Building plant in Detroit. The Chicago office added a list of four plants, comprising 12 stokers, and including a 48-in. 20-grate stoker to Sligar & Holloway, Indianapolis; one 84-in. 22-grate stoker to the United States Board and Paper Company, of Carthage, Ind.; eight 54-in. 22-grate stokers to the United States Mining Company at Salt Lake City, Utah, and two 93-in. 22-grate stokers to Deere & Co., of Moline, Ill.

QUAKER CITY RUBBER COMPANY, Philadelphia, manufacturer of the well-known P. P. P. packing, reports a constant influx of commendatory letters from users of its packing. The following extract from one of the letters recently received is a fair specimen of the character of all of them:

"I take pleasure in writing to you corroborating my statements recently made to you, to the effect that we pack all packed plungers on high-duty, crank, and fly-wheel pumping engines with your Daniel's P. P. P. packing, and we have found this packing to effect a saving in engine friction of just 50 per cent when replacing braided flax packing. * * * One year ago we packed one of our cross-compound packed engines with 16-in. outside center packed plungers, inserting three rings of the same in each stuffing box. This same packing, installed a year ago, has been in continuous service ever since, the engine operating day and night at 250 ft. piston speed, and pumping against 75 lbs. water pressure. At times the water has been very gritty, and conditions, we might say, the worst they could have been for packing. The packing has not been touched once during the past year, and so far as we know it is in as good condition to-day as when applied. This may seem to you and some others that it is pretty far-fetched, but should anyone doubt the statement we would be most pleased to furnish proof.* * * C. M. SCOTT,

Chief Engineer.

Snow Steam Pump Works, Buffalo, N. Y.


INDUCTION COILS AND COIL MAKING
NORRIE
SPON & CHAMBERLAIN

An
American Book
with
American Gauges
and
American Types

2d edition, revised and greatly enlarged.

Full descriptive circular on application.

PRICE, $1.00.

SPON & CHAMBERLAIN,
12 CORTLANDT ST., NEW YORK.
Send 2 cents for our new Catalogue.

PATENTS SECURED

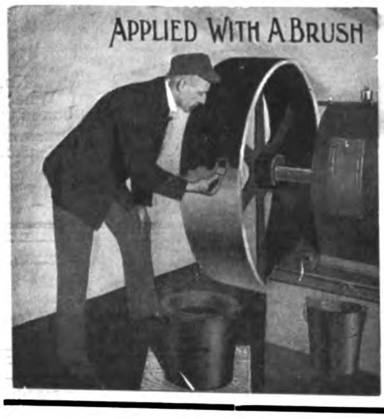
Examinations and Opinions as to Infringement and Validity. Suits Conducted. Booklet Relating to Patents Mailed Free.

WILLIAM F. HALL,
Suite 7-8 Equitable Bldg., Washington, D. C.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.



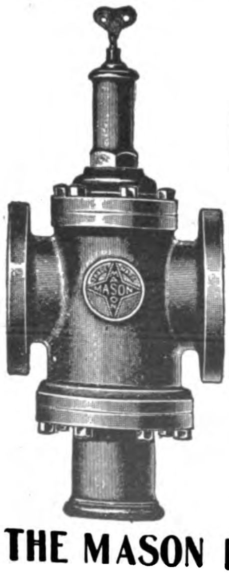
WARREN'S PULLEY COVER

Should be on every dynamo and alternator pulley.
It positively overcomes belt slipping.

THE PROOF!

Repeated re-orders from users of power everywhere.
It is sent on trial, to be paid for only if found satisfactory.
We want you to give it a trial. Write for particulars to-day.

THE WARREN COMPANY, Inc.
MANUFACTURERS,
253 N. Franklin Street, - Chicago, Ill.



THE MASON
Reducing Valves

ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

Vol. XIV. New York, March, 1902. No. 3.

A MODERN DISTRICT CENTRAL STATION.

PLANT OF THE WESTCHESTER LIGHTING COMPANY, AT NEW ROCHELLE, N. Y.

An excellent example of a suburban central station, the output of which is used chiefly for residential lighting, is furnished by the plant of the Westchester Lighting Company at New Rochelle, N. Y. The station was built by the United Gas Improvement Company of Philadelphia, and supersedes stations at Mt. Vernon, Mamaroneck and City Island. These latter stations have been dismantled and converted into sub-stations, their equipment now consisting of G. E. series regulators and of step-up transformers which raise the voltage from 2300 to 4400 volts for street lighting distribution. The current generated at the station is all two-phase, 60-cycle, and the bus-bar potential is 2300 volts.

The power-house is a brick building 117 ft. 6 ins. long, 103 ft. 4 ins. wide, and 39 ft. 6 ins. high, surmounted by a tile roof supported on steel trusses. The boiler and engine rooms run side by side the entire length of the building, the former occupying 45 ft. of the width and the latter 54 ft. In one corner of the boiler room are two duplex boiler-feed pumps, one fire pump, and a 1500-h.p. Webster "Star" vacuum feed-water heater, the latter built by Warren Webster & Co., of Camden, N. J. The chimney is situated to the west of the building and was built by the Alphons Custodis Chimney Construction Company of New York, from hollow radial moulded brick. It is 175 ft. high and has a base 16 ft. square; the flue diameter at the bottom is 14 ft. 6 ins. and the diameter at the top is 7 ft. The draft is regulated by an automatic damper regulator made by the Locke Regulator Company, of Salem, Mass.

The boiler room contains four Stirling boilers rated at 250 horse-power each at a steam pressure of 150 lbs., set and connected in batteries of two. Coal is brought in barges up through a channel in Echo Bay to the company's dock, whence it is

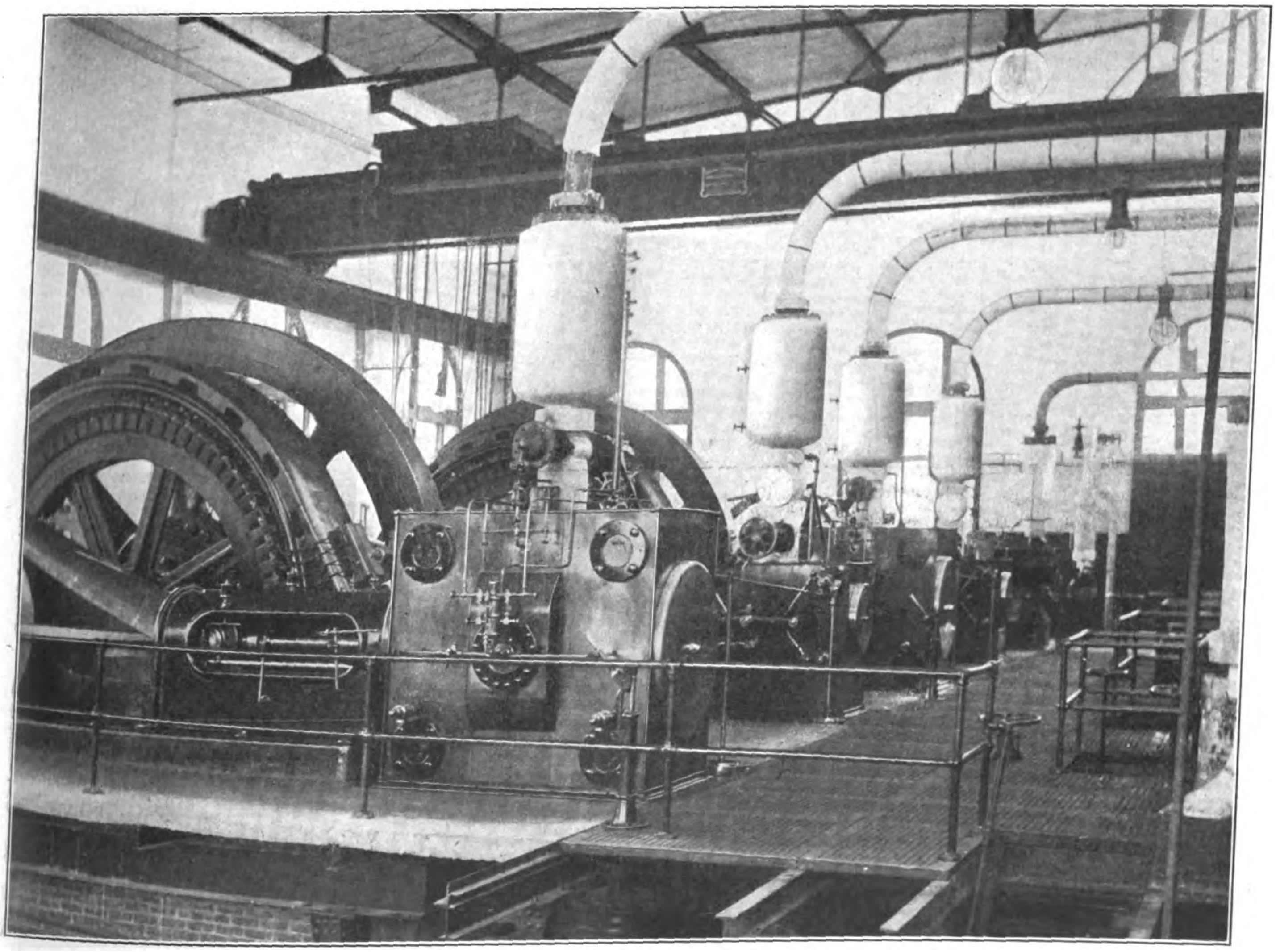


FIG. 1.—ENGINE AND GENERATOR ROOM OF THE WESTCHESTER LIGHTING COMPANY AT NEW ROCHELLE.

hoisted and conveyed, by an automatic coal-handling system built by the John A. Mead Manufacturing Company of New York, to a bin of 1000 tons capacity situated outside of the building. Chutes from the bin deliver the coal to steel charging cars which run on tracks in front of the furnace doors, and the coal is shoveled direct from the cars into the furnaces. The fuel used is anthracite pea, and the boilers are hand fired. Fig. 2 shows the boiler room equipment. Feed water is taken from the city mains, and after passing through the Webster heater is delivered to a duplicate set of extra heavy 3-in. wrought iron water pipe mains, whence it is fed through 2½-in. brass pipes to the boilers. Each boiler is provided with a 2½-in. wrought iron blow-off pipe emptying into a catch basin which drains into the bay. The room contains available space for another set of boilers of somewhat larger size than those already installed, and these have already been ordered from the Stirling Company.

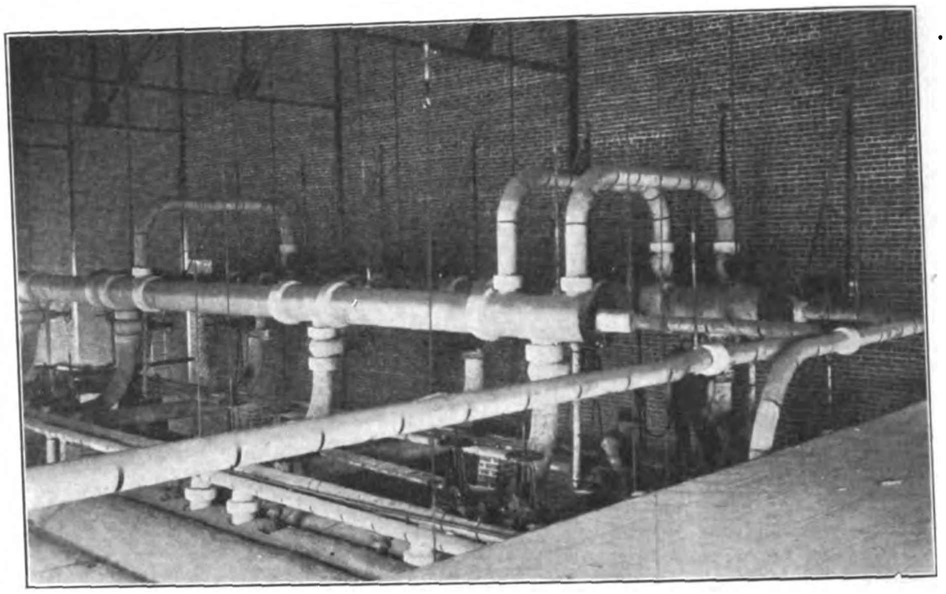


FIG. 3.—VIEW OF STEAM PIPING ABOVE BOILERS.

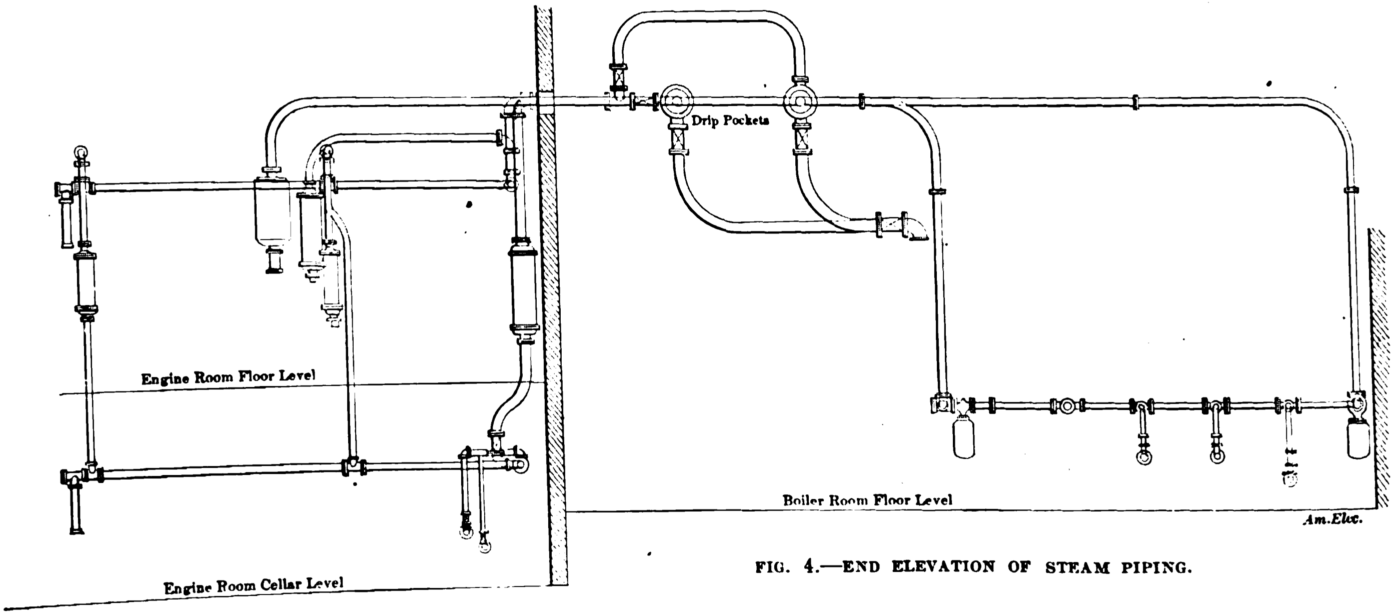


FIG. 4.—END ELEVATION OF STEAM PIPING.

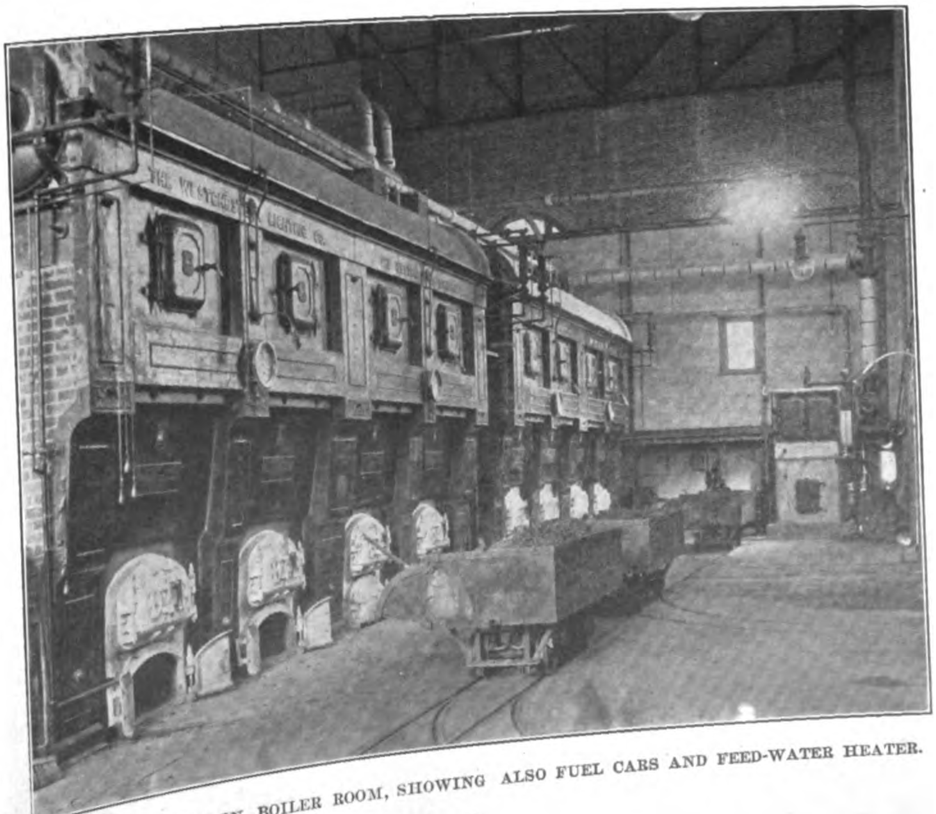


FIG. 2.—VIEW IN BOILER ROOM, SHOWING ALSO FUEL CARS AND FEED-WATER HEATER.

The steam piping system consists of two 16-in. headers extending across the rear of the boiler room, into which two 8-in. mains turning upward in long bends from each pair of boilers deliver steam. These connections are shown in Fig. 3. Individual 6-in. mains are taken in long bends through the boiler room partition wall from these headers to the two larger engines; the three smaller engines are fed from duplicate 5-in. mains in the engine room. Each engine supply pipe is provided with a Cochrane steam separator. A 5-in. header in the basement of the engine room is fed by a duplicate set of 6-in. mains and supplies steam to the condenser pumps. Two 3-in. mains, one from each header, supply steam to the fire and feed-water pumps in the boiler room. All steam piping is extra-heavy with cast-steel flanges and fittings, and is covered with magnesia lagging. Kieley steam traps are used throughout for the pipe drips, and Geiper steam traps, made by Thorp, Pratt & Co., of New York, are provided for the engine cylinders.

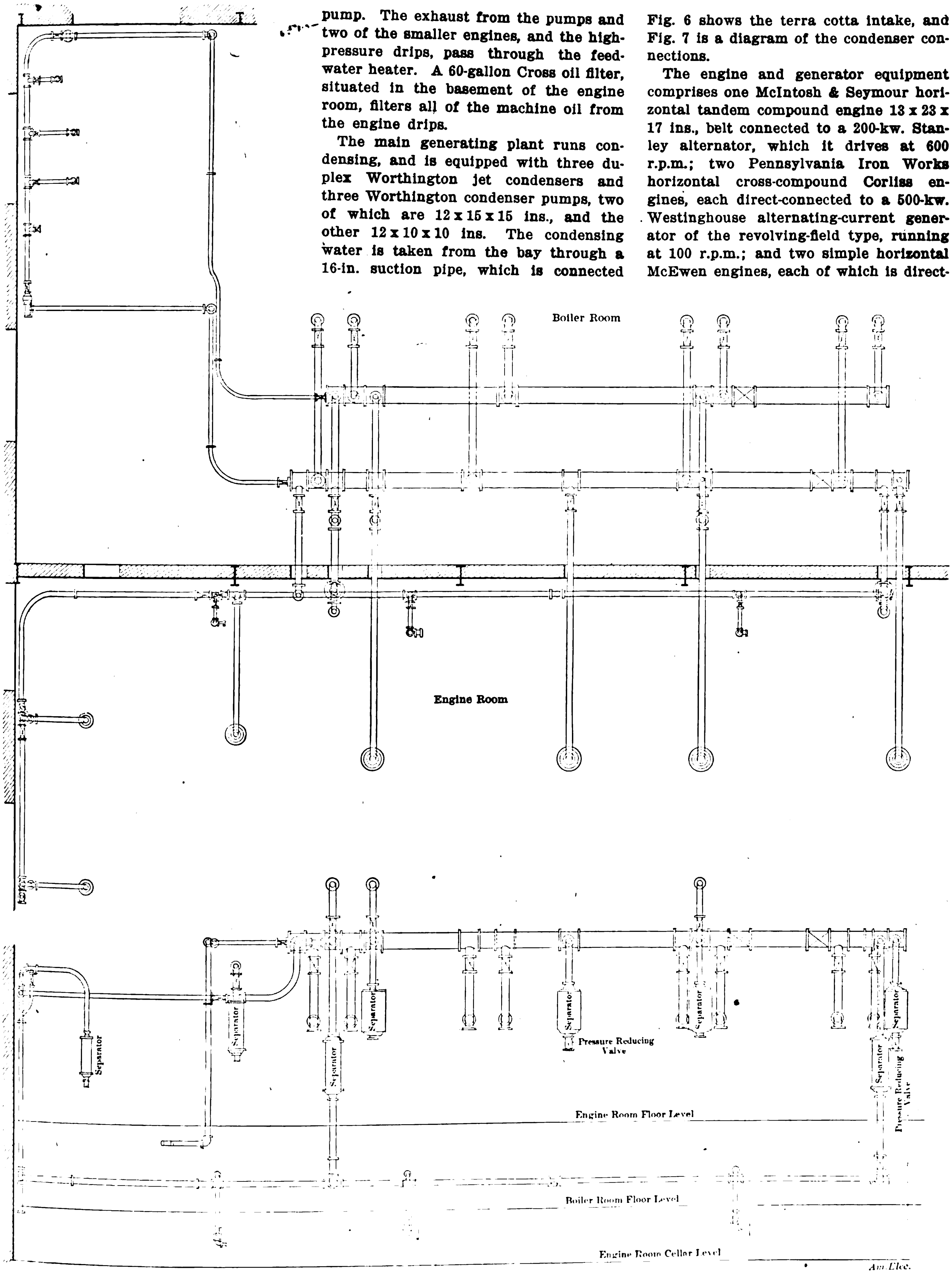

Boiler Room
Engine Room
Separator
Separator
Separator
Separator
Separator
Separator
Separator
Separator
Pressure Reducing Valve
Pressure Reducing Valve
Engine Room Floor Level
Boiler Room Floor Level
Engine Room Cellar Level
Am. Elec.

FIG. 5.—PLAN VIEW AND FRONT ELEVATION OF STEAM PIPING.

All of the drips from the receivers discharge into a hot well in one corner of the engine room basement, and the water there is thrown out into the bay by a Davidson pump. The exhaust from the pumps and two of the smaller engines, and the high-pressure drips, pass through the feed-water heater. A 60-gallon Cross oil filter, situated in the basement of the engine room, filters all of the machine oil from the engine drips.

The main generating plant runs condensing, and is equipped with three duplex Worthington jet condensers and three Worthington condenser pumps, two of which are 12 x 15 x 15 ins., and the other 12 x 10 x 10 ins. The condensing water is taken from the bay through a 16-in. suction pipe, which is connected through a continuous service foot-valve with a 30-in. terra cotta intake extending out into the bay, and a 16-in. cast iron discharge pipe carries back the warm water. Fig. 6 shows the terra cotta intake, and Fig. 7 is a diagram of the condenser connections.

The engine and generator equipment comprises one McIntosh & Seymour horizontal tandem compound engine 13 x 23 x 17 ins., belt connected to a 200-kw. Stanley alternator, which it drives at 600 r.p.m.; two Pennsylvania Iron Works horizontal cross-compound Corliss engines, each direct-connected to a 500-kw. Westinghouse alternating-current generator of the revolving-field type, running at 100 r.p.m.; and two simple horizontal McEwen engines, each of which is direct-connected to a 25-kw. direct-current Westinghouse generator running at 300 r.p.m. These last-named engines run non-condensing. The Stanley generator has 12

poles and delivers two-phase current at 2300 volts and 60 cycles. Its field is excited by a 6½-kw. 125-volt Westinghouse dynamo, which is belt-driven from the alternator shaft. Each of the Westinghouse alternators delivers two phase-current at 2300 volts and 60 cycles. After

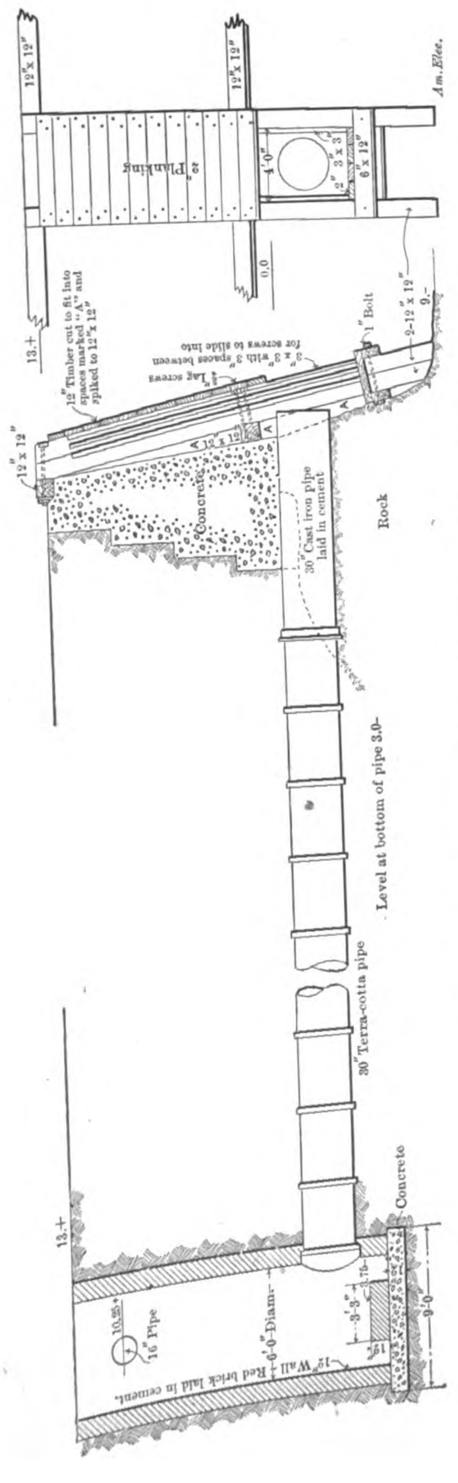

12" x 12"
12" x 12"
4" Planking
4'-0"
2" 3" x 3"
6" x 12"
0.0
13.+
12" Timber cut to fit into spaces marked "A" and spiked to 12" x 12"
3" x 3" with 3 spaces between for screws to slide into
Lag screws
1" Bolt
2-12" x 12"
9-
12" x 12"
A
A
Concrete
30" Cast iron pipe laid in cement
Rock
Level at bottom of pipe 3.0-
30" Terra-cotta pipe
13.+
Concrete
10.25+
16" Pipe
6'-0" Diam-
12" Wall - Red brick laid in cement.
3'-3"
3.75
9-0
Am. Elec.

FIG. 6.—SIDE AND FRONT ELEVATIONS OF CONDENSER INTAKE.

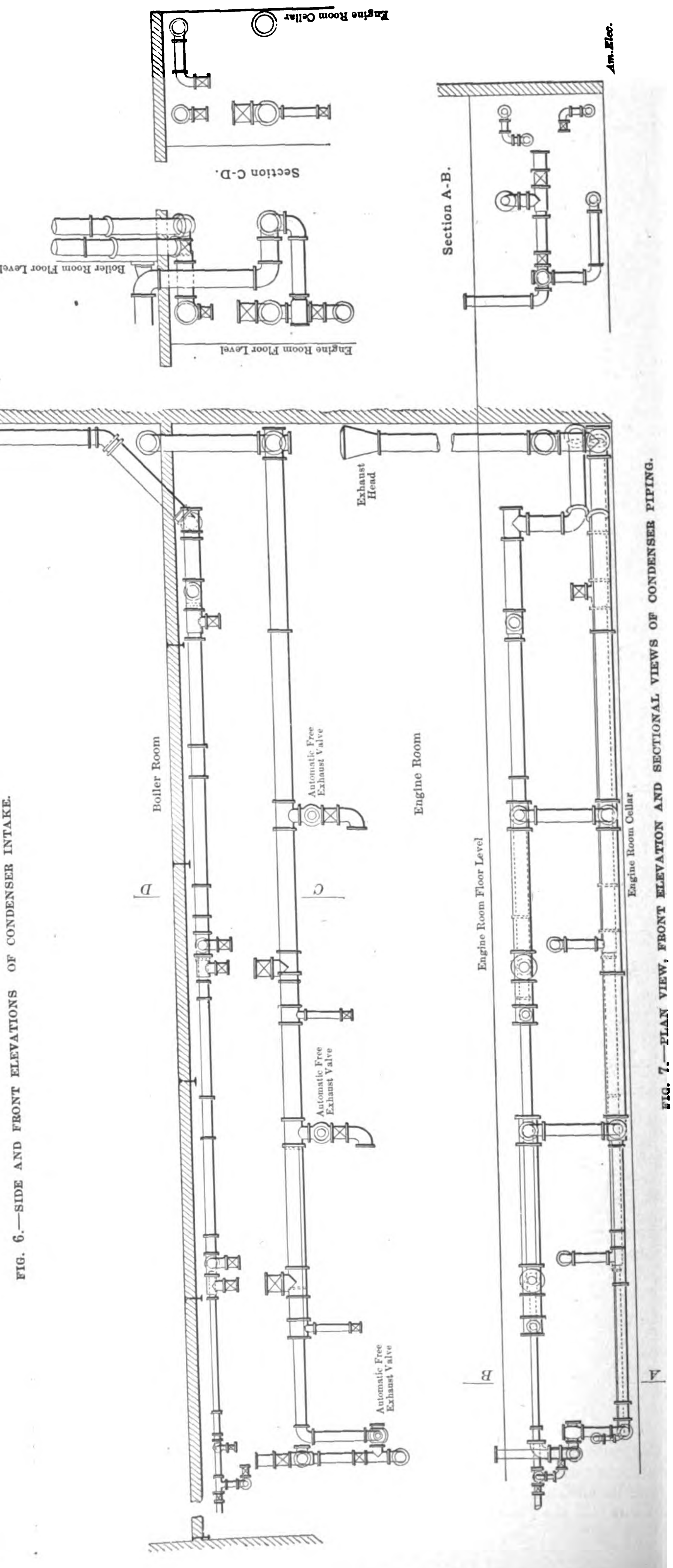

Engine Room Cellar
Section C-D.
Boiler Room Floor Level
Engine Room Floor Level
Section A-B.
Am. Elec.
Exhaust Head
Boiler Room
Automatic Free Exhaust Valve
Engine Room
D
C
Automatic Free Exhaust Valve
Automatic Free Exhaust Valve
Engine Room Floor Level
Engine Room Cellar
B
A

FIG. 7.—PLAN VIEW, FRONT ELEVATION AND SECTIONAL VIEWS OF CONDENSER PIPING.

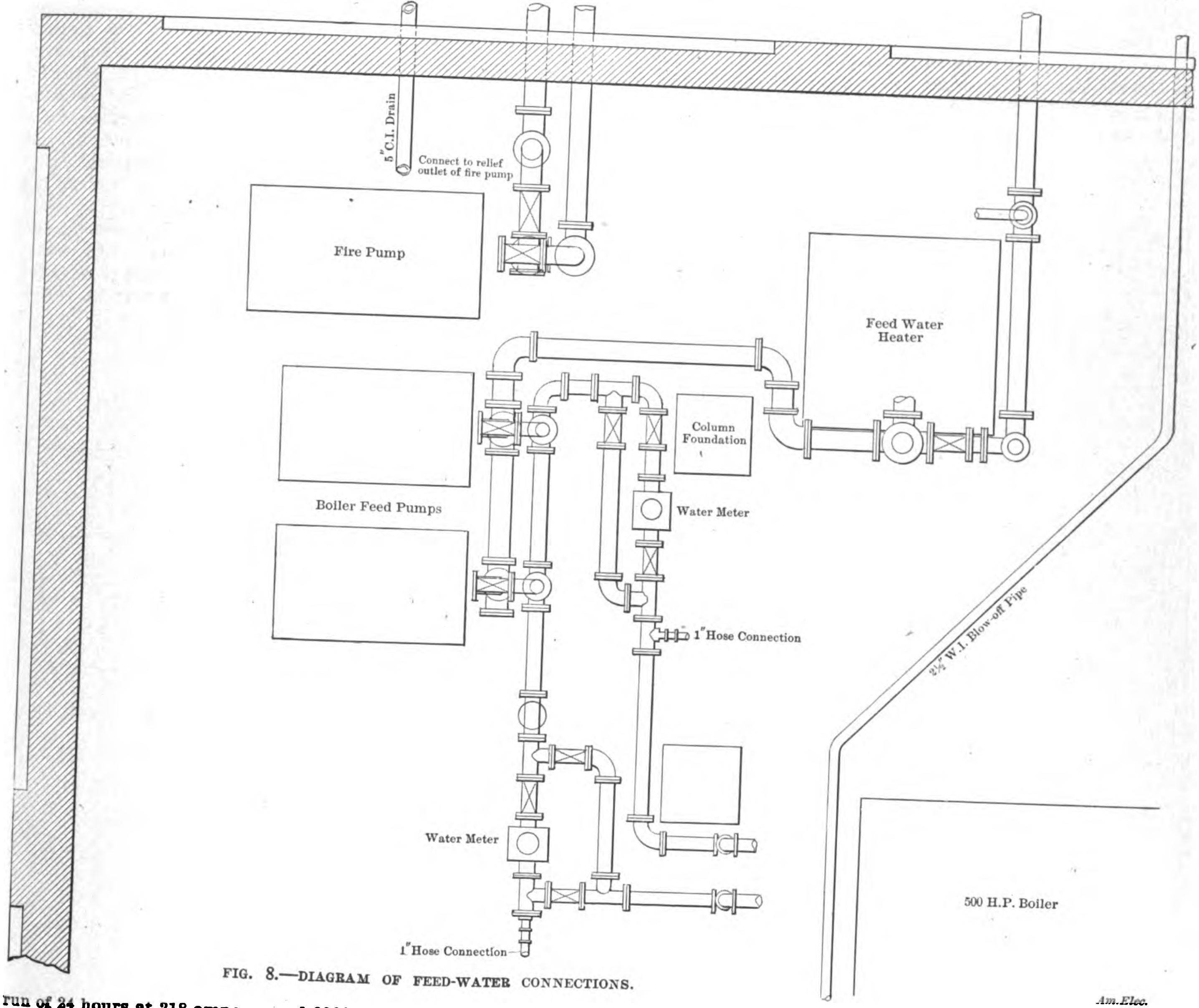

5" C.I. Drain
Connect to relief outlet of fire pump
Fire Pump
Feed Water Heater
Column Foundation
Boiler Feed Pumps
Water Meter
1" Hose Connection
2½" W.I. Blow-off Pipe
Water Meter
500 H.P. Boiler
1" Hose Connection

FIG. 8.—DIAGRAM OF FEED-WATER CONNECTIONS.

Am.Elec.

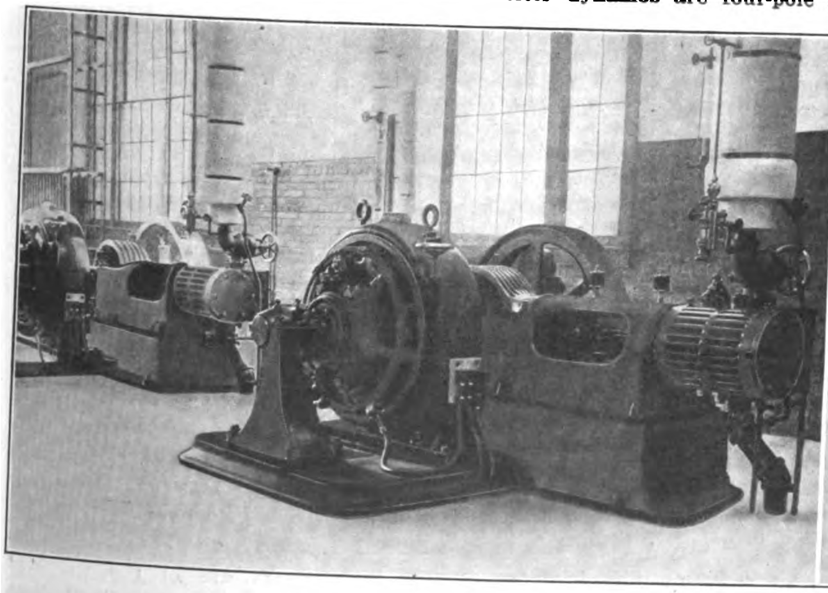


FIG. 9.—VIEW OF EXCITER UNITS.

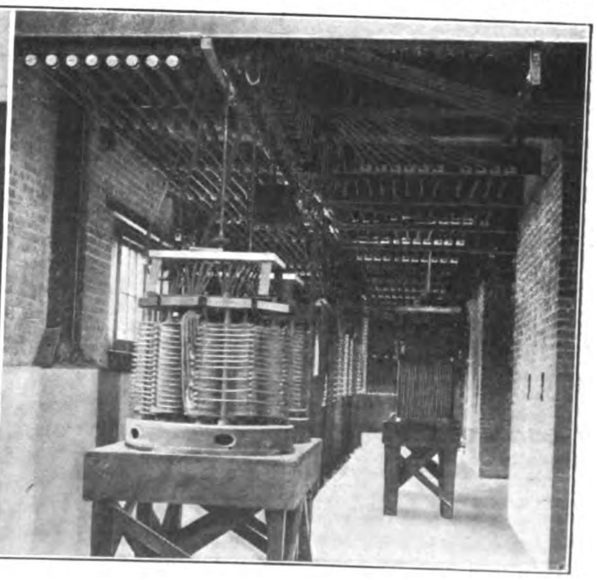


FIG. 10.—BUS BARS, REGULATORS, ETC., IN BASEMENT.

a run of 24 hours at 218 amperes and 2300 volts the temperature of the armature, field coils, or rectifying commutator is guaranteed not to rise more than 40° C. above the temperature of the surrounding air, and with the load then increased to 150 per cent of the normal load for two hours the temperature is guaranteed not to rise more than 50° C. The 25-kw. exciter dynamos are four-pole machines and supply current to excite the fields of the large alternators. A view of the exciter units is given by Fig. 9.

The Pennsylvania engines have cylinders 18 ins. and 36 ins. in diameter and 42 ins. stroke. With a steam pressure of 160 lbs. at the throttle, and 26 ins. vacuum at the low-pressure cylinder, the most economical capacity is 750 horse-power at a speed of 100 r.p.m. A feature of the engines is their massiveness and rigidity of construction. The bed plate is of the box type, cast in one piece and giving a continuous bearing surface on the foundation from the main bearing to the cylinder. The bearings are of the quarter box type, both side cheeks being provided with wedge adjustment. The bearing shells are of cast iron, babbitt-lined and water-jacketed. The fly-wheel is of the segmental rim design, 18 ft. in diameter and weighing approximately 70,000 lbs. The connecting rods are made of open-hearth steel, both ends being solid, and have babbitt-lined bronze boxes provided with wedge adjustment. The cross-heads are made from steel castings, turned up, and have babbitt-faced wedge-adjusted slippers which are driven positively by the cross-head, so that none of the strain comes upon the adjusting screws. In attaching the cylinder to the bed frame and foundation, special provision is made for allowing them to expand without getting out of alignment.

The governors are of the weighted Watt type, driven by gearing direct from the crank shaft, thus eliminating the usual governor belt. The governor spindle and rock-shaft work in ball bearings, to reduce the friction to a minimum. In designing the governing gear, special at-

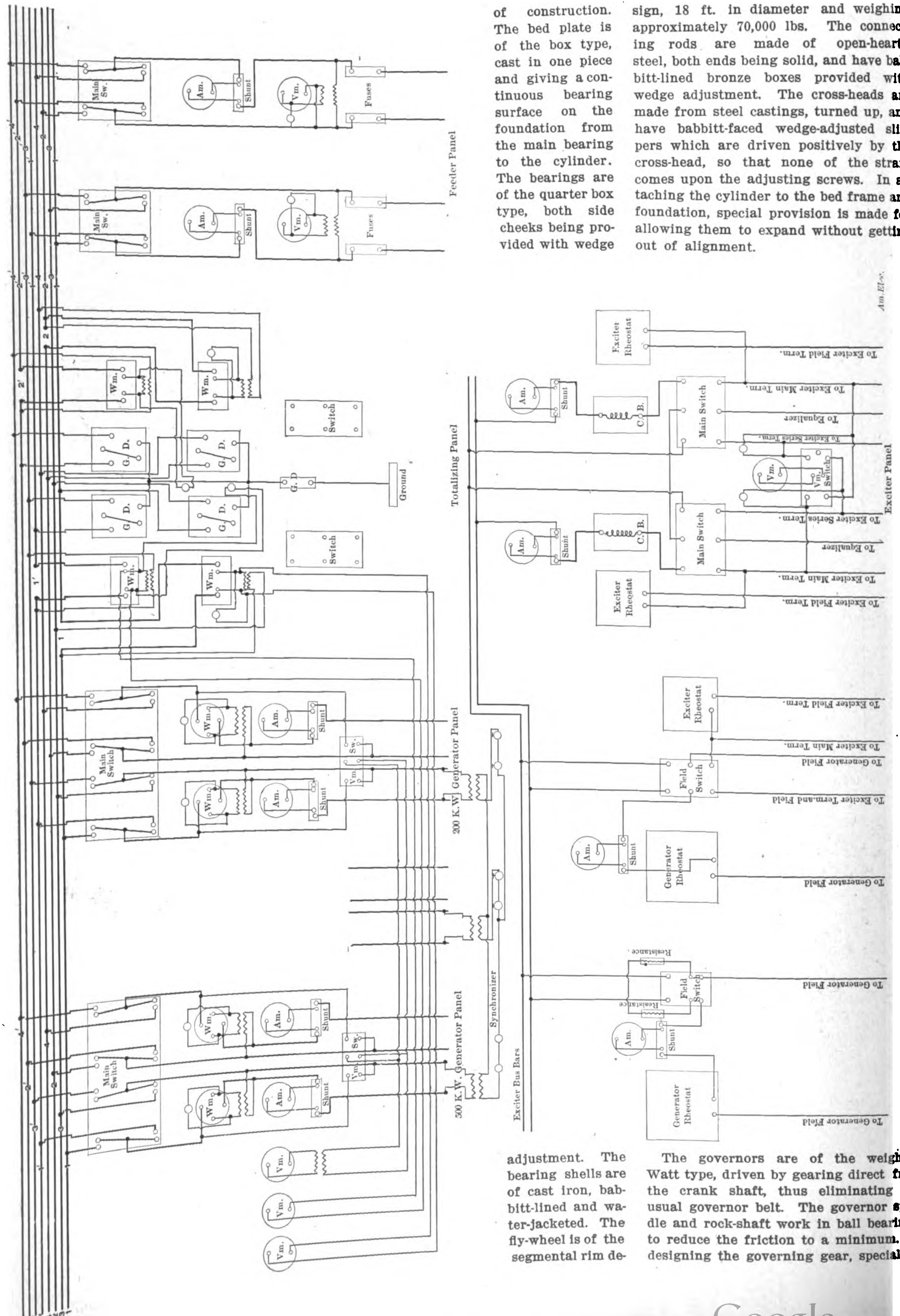

Feeder Panel
Main Sw.
Am.
Shunt
Vm.
Fuses
Wm.
G. D.
Switch
Ground
Totalizing Panel
Exciter Panel
Exciter Rheostat
To Exciter Field Term.
To Exciter Main Term.
To Equalizer
To Exciter Series Term.
C. B.
Main Switch
Vm. Switch
Main Switch
Sw.
200 K. W. Generator Panel
500 K. W. Generator Panel
Synchronizer
Exciter Bus Bars
Field Switch
To Generator Field
To Exciter Term. and Field
Generator Rheostat
Resistance
Am. El-c.

FIG. 11.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

tention was given to the fact that the engines were to be used for driving alternators in parallel, and the speed regulation is such that the two generators always operate successfully together. The valve-gear is of the pendant type of double-ported Corliss liberating gear. The admission and exhaust valves are operated by separate eccentrics, enabling the cut-off to be carried to three-quarter stroke. The rocker arms are provided with self-contained out-board bearings. A permanent indicator reducing motion of the rifle-barrel type is fitted to each engine. The oil guards and panning of the engines are so constructed that it is impossible for any oil to reach the generator or to be thrown on the floor. All adjustments are made by means of wedge and screw, and the engines are piped so that either side may be run independent of the other and either condensing or non-condensing. A safety stop mechanism is provided, whereby the steam supply is cut off automatically in case the speed exceeds a predetermined limit.

A two-carriage traveling crane traverses the entire length of the engine room. It was built by the Brown Hoisting Machine Company, of Cleveland, Ohio, and has a capacity of 18 tons. Sufficient space has been left for an additional 850-kw. Pennsylvania-General Electric unit, soon to be installed. At present the 200-kw. Stanley alternator is large enough to carry the all-day load, and the plant is run at its full capacity at night.

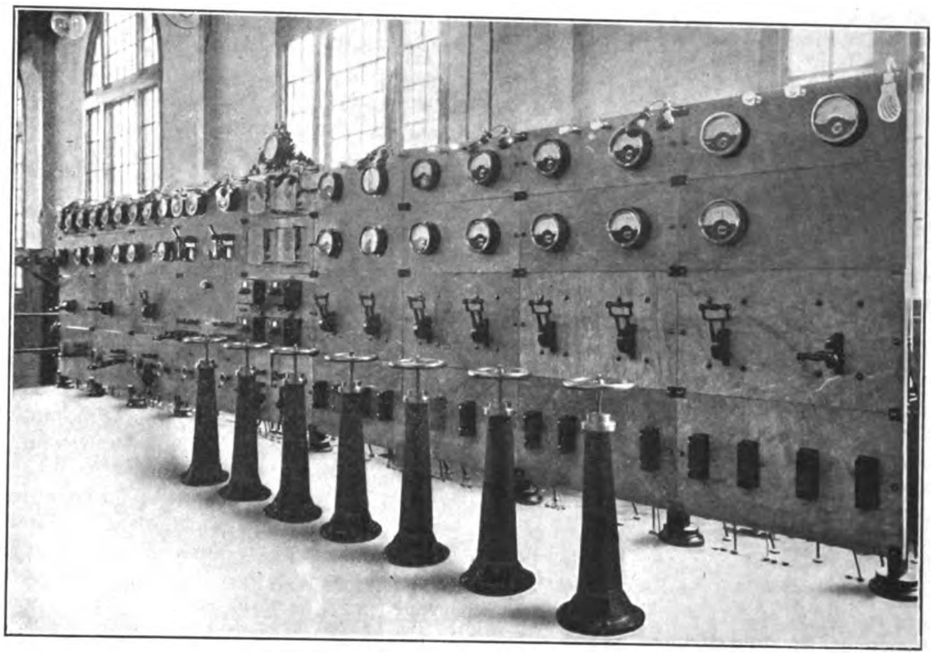


FIG. 12.—VIEW OF SWITCHBOARD.

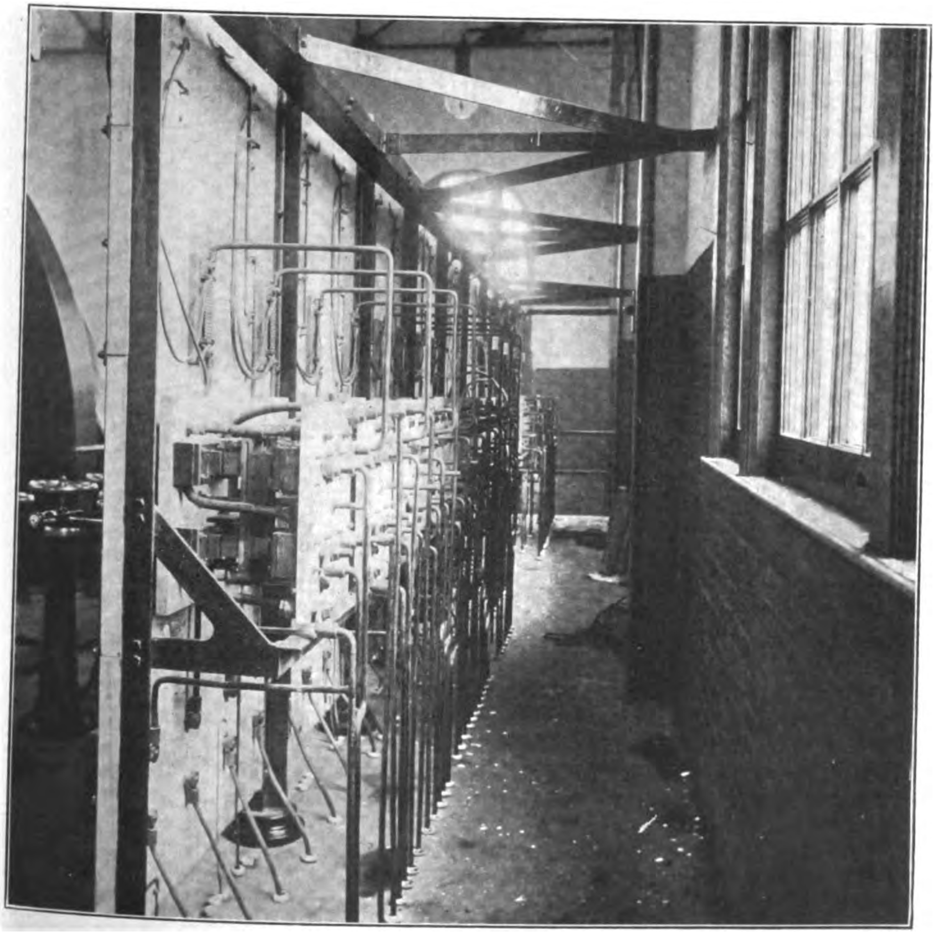


FIG. 13.—REAR VIEW OF SWITCHBOARD.

The switchboard was built by the Stanley Electric Manufacturing Company, of 2-in. blue Vermont marble, free from metallic traces, with polished and beveled faces and edges. It contains two 500-kw. generator panels, one 200-kw. generator panel, one exciter panel, one totalizing panel and four single-phase double feeder panels. The panels are supported on angle irons resting on insulated blocks, and are braced from the rear walls by insulated iron rods. The board is equipped with a double set of two-phase bus-bars, suspended from the ceiling of the basement, immediately below the switchboard. The generator and feeder panels are provided with double-throw switches which connect the generators and feeders to either side of the bus-bars. The voltmeter, shunt coils, indicating and recording wattmeters and synchronizing lamps are all connected to the potential bus-bars, which run from the main bus-bars through potential transformers, all of which are provided with primary fuses. Pilot lamps are connected as shown in the wiring diagram, Fig. 11.

The generator panels were designed for parallel running, and each of the larger panels has two 175-ampere ammeters, two 375-kw. indicating wattmeters, one 150-ampere direct-current alternator-field ammeter, one four-pole double throw switch capable of breaking a circuit of 200 amperes and 2500 volts, one double-pole alternator-field switch of 150 amperes capacity with carbon contact points to prevent arcing; one four-pole double-throw switch for the potential bus-bars, voltmeter plug receptacles, synchronizing and pilot lamps and generator field rheostats, the head and wheels of which are mounted on the switchboard. The smaller generator panel has two 60-ampere ammeters, one four-pole double-throw switch capable of carrying 200 amperes, one four-pole double-throw switch for the potential bus-bars, one double-pole double-throw exciter switch and the usual rheostats. The exciter panel contains a direct-current 300-ampere round pattern ammeter, a 750-ampere ammeter, a voltmeter, a single-pole circuit-breaker, a 750-ampere circuit-breaker and two triple-pole single-throw switches. On the totalizing panel are four recording watt-hour meters of 500 kilowatts capacity and four ground detectors of the static type, one on each main bus-bar; each ground wire being provided with a switch, and two double-pole throw switches for the station lights.

The feeder panels carry four fuse-blocks provided with 100-ampere fuses, two ammeters, two double-pole double-throw switches, and three of the panels are provided with two 150-volt voltmeters. Each of the seven circuits is equipped with a Stillwell inductive regulator capable of varying the voltage 275 volts either way from the bus-bar e.m.f. of 2300 volts. The regulators are located in the basement of the engine room and the seven hand wheels are situated as shown in Fig. 12, directly in front of the feeder panels. Fig. 10 is a view in the basement showing the bus-bars, rheostats and Stillwell regulators.

Twin wires are used for all potential connections, and all leading-in and leading-out terminals have lugs large enough to receive No. 00 cable. All the wiring in the building is carried on porcelain insulators, mounted on iron racks. The main bus-bars are made of 9/16-in. insulated copper rod, the exciter bus-bars are of ¾-in. copper rod, the main connections on the exciter panel are made with 9/16-in. copper rod, and the main connections on the generator and feeder panels are made with No. 00 cable. The field connections on the larger generator panels are made with No. 00 cable, while the field connections on the smaller generator panel are made with No. 2 wire, as are also the switch connections on the totalizing panel. The potential "bus-bars" consist of No. 8 rubber-covered wire, and the connections to the voltmeters, wattmeters, shunts, ground detectors and pilot lamps are made with No. 12 rubber-covered wire.

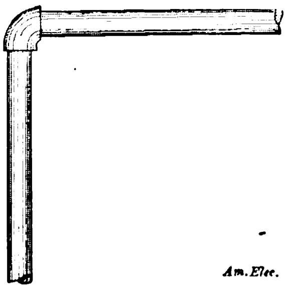


FIG. 1.—RIGHT-ANGLE TURN.

To the right of the main switchboard is the arc light switchboard, which was installed by the General Electric Company. The present capacity is for six circuits, with a temporary panel for a seventh circuit. Fifty G. E. series enclosed 6.6-ampere arc lamps are run on each circuit. The circuits are supplied through four 100-light constant-current (tub) transformers situated in the basement just below the arc-light switchboard. The primaries are wound for 2200 or 4400 volts, and each transformer has a capacity of 60 kilowatts. Lightning arresters are placed at suitable intervals on the poles, and wherever it is desired to reduce the voltage for residential lighting ordinary transformers are installed on the poles and bring the line potential down to 104 volts.

Mr. Matthew G. Kennedy is superintendent of the station at New Rochelle, and it is to Mr. Kennedy's courtesy that we are indebted for the data contained in this article.

TRANSVERSE STRESSES IN STEAM PIPES.

BY A. S. MANN.

MINIMUM LENGTH FOR TWO PIPES AT RIGHT ANGLES, CONNECTED AT THE ENDS.

When two steam pipes are connected by a right-angle elbow as shown in Fig. 1, the expansion of each has an effect upon conditions of stress in the other. This is a fact also with two pipes, however they be connected, but in previous articles it has been assumed that the main pipe was free to move sidewise, or that it had at least sufficient latitude of movement to allow the branch pipe to expand as it would. Also the comparatively slight deflection in the main itself has been disregarded in the derivation of formulæ. In the case shown in Fig. 1 both pipes deflect, and if they be of equal length and of equal diameter one deflects as much as the other. The condition shown in Fig. 1 is met with when the last of a row of boilers is to be connected to the main pipe, and, in general, is true of a last branch anywhere. The connection would be used wherever it was desired to connect two nozzles at right angles to carry steam or hot water from one receptacle to another, and in common practice a designer would hardly hesitate to use it wherever occasion required, and he would not feel that there was a minimum length for two equal legs, as shown here. It will be demonstrated in this article that there is a minimum length for the two pipes, and if they are made shorter than this minimum length, either they will be stressed beyond the desirable amount, or the boiler or tank, or whatever it may be to which the attachment is made, must spring enough to make up the difference.

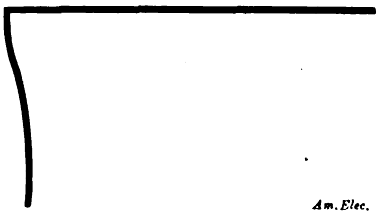


FIG. 2.—STRESSED BRANCH.

If the two arms are each pretty long and one is considerably longer than the other, so that the expansion of the longer one calls for much the greater lateral deflection, a part of the bending will take place in the long pipe itself. That is, the long arm will not be stiff enough to make the short arm assume the form of a complete reverse curve; instead of the branch taking the shape shown exaggeratedly in Fig. 2, part of the bending works over into the other arm, as shown in Fig. 3, and it is possible to have lengths so proportioned that the short arm bends as a single cantilever, using its whole length to best advantage.

The problem is to find an equation expressing the relation between l and L in Fig. 3, and both l and L will be known when the value of v is known. In Fig. 2, which shows a complete reverse curve in the short arm, there is a bending moment in the arm where it joins the other pipe. This bending moment has to be resisted by something, for an unbalanced bending moment, which is really an unbalanced couple, would produce motion. There are no external forces acting to make any alteration of the amount of the bending moment, so the only change that can take place in the value of the moment must come from change of position of the section under consideration. That is, the bending moment has a different value at different transverse sections, but the change is a uniform one which may be expressed by a single algebraic equation. It is clear that the bending moment in the branch at its joint with the main pipe is equal to the bending moment in the main pipe at its joint with the branch if these two sections are adjacent. This is more apparent if the branch and main are supposed to be joined by a bend of short radius in the pipe itself. And if the length of the pipe is taken around the curve at its center line, it is just as apparent if the pipes are joined by an elbow. So far as deflection is concerned, the two pipes may be considered to be in one straight line, as shown in Fig. 4, where the length of the branch pipe is l and the length of the main is L, and the deflection which is to be determined is v, which is equal to .00125 L.

While the beam or pipe bends in this form the only fact shown about the curve thus far is that there is a bending moment at the end A, whose value is as great as it may safely be, and if therefore of known magnitude it may be computed from the equation:

$$m = 2x\frac{I}{D}.$$

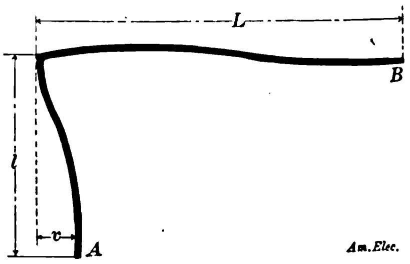


FIG. 3.—STRESSED BRANCH AND MAIN.

Considering now the branch shown in Fig. 2, and which makes a complete reverse bend with ends parallel to the direction which they would have when unloaded, the bending moment at the end piped to the nozzle is balanced by a bending moment of precisely the same magnitude at the other end of the branch. This has been demonstrated in the preceding article. The same demonstration will apply to Fig. 3. That is, the bending moment at the end of the main B is equal in magnitude to the bending moment at the end of the branch A. Then the whole length of the pipe shown in Fig. 4 may be considered as a single beam, having both ends so fixed that there is no angular movement at the supports, however much the loads may be and having the bending moments at the two ends equal.

Since there are no external forces acting on the beam, the bending moment must vary in accordance with the first power of the distance from any chosen origin to the section. That is, if the value of the bending moments at a series of consecutive joints be represented by lines normal to a base line, their lengths being proportional to the bending moments, the ends of these lines will all lie in a straight line. There are also two points of flexure in the beam, that is, points where there are no bending moments, and therefore no stresses, either tensile or compressive, in any of the fibers at that section. Also the two half lengths of the beam are precisely alike and the bending moment at the center is a maximum and is equal to the bending moment at either end.

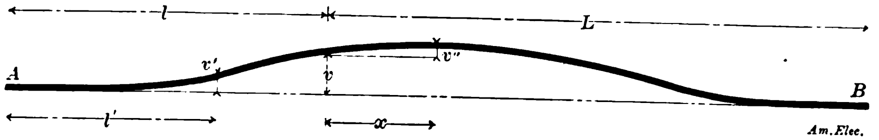


FIG. 4.—DEFLECTION OF TWO PIPES WHEN CONSIDERED AS ONE.

Now, considering only one-half of the total length in Fig. 4, it is clear that that half is bending in just the same way that the branch shown in Fig. 2 is bent; that its ends are parallel, have equal bending moments, and are subject to a constant shearing force throughout the length of this half. What is true of one half of the beam is true of the other. The point of flexure is half-way between the center and the end in each half, and the bending moment may be represented graphically by Fig. 5, where *A B* is the base line whose length represents the over-all length of the beam, and *C F D* is the line of bending moments, the bending moment at any point being equal to the intercept of the ordinate at that point. The points of flexure are shown where *E B* crosses *F D*, and the sign of the bending moment changes from plus to minus at the intersection.

In Fig. 4, *L* is the length of the main pipe, *l* the length of the branch, and *L* + *l* is the length of the whole when considered as a beam; *l'* gives the length of that part of the beam from one end up to the point of deflection. From what has already been said, it is clear that

$$l' = \frac{L + l}{4}.$$

There will be two cases for each of which the deflection must be determined, depending upon whether the point at which the deflection is to be calculated lies at the left or at the right of the point of deflection. If the center of the whole length be taken as the origin, and *x* the distance to the point representing the corner, an expression will be found first where *x* is less than *l'* and consequently *l* will be greater than *l'*. The general expression for the deflection of a cantilever beam loaded at one end is:

$$v = -\frac{w}{EI}\left(\frac{l's^2}{2} - \frac{s^3}{6}\right),$$

which is the equation of the curve which the center line of the beam assumes, the whole length being *l'*, and *s* the abscissa, and *v* the ordinate of any point on the curve, and since the maximum bending moment $m = w\ l'$ and $\frac{m}{I} = \frac{2x}{d}$, then

$$v = \frac{x}{dE}\left(\frac{s^3}{3l'} - s^2\right).$$

This equation is true for all points between the middle of the beam and the point of flexure. Making $s = x = 2l' - l$, and substituting this value of *s* in the equation will give a value of *v''* at the point in Fig. 4 where the elbow lies. In substituting

$$\frac{(2l' - l)^3}{3l'} = \frac{8}{3}l'^2 - 4\,l'l + 2\,l^2 - \frac{l^3}{3l'}$$

and

$$(2l' - l)^2 = 4l'^2 - 4l'l + l^2.$$

Taking the difference between these last two as the equation for *v* demands, the expression for *v''* becomes

$$v'' = \frac{x}{dE}\left(-\frac{4}{3}l'^2 + l^2 - \frac{l^3}{3\,l'}\right).$$

v' is clearly a limiting case of *v''*, and where $v'' = v'$, $s = l'$, so

$$v' = -\frac{2}{3}\,\frac{x}{dE}\,l'^2.$$

From the figure it is apparent that $v''' = 2v' - v''$, therefore:

$$v = -\frac{x}{dE}\left(\frac{4}{3}l'^2 - \frac{4}{3}l'^2 + l^2 - \frac{l^3}{3\,l'}\right) =$$

$$-\frac{x}{dE}\left(l^2 - \frac{l^3}{3\,l'}\right).$$

Now since

$$l' = \frac{L + l}{4},\quad v = -\frac{x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right)$$

It is clear that *v* here is the *v* shown in Fig. 3, and its value is .00125 *L*, that is, this deflection will take care of the expansion in a definite length of main pipe. Then the relation between *L* and *l* is expressed by the equation:

$$L = -\frac{800x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right),$$

and for a given value of *l* the value of *L* may be computed, since the other algebraic quantities have known numerical values for a given size of pipe.

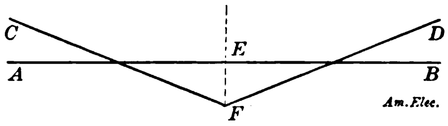


FIG. 5.—BENDING MOMENT REPRESENTED GRAPHICALLY.

This equation expresses the relation between *L* and *l* when *x* is greater than *l'*, as will follow from this demonstration. The deflection *v* which it is desired to know in this case is the deflection of a simple cantilever at a point a distance *l* from the support, and whose length is *l'*, the load being at the end, so that

$$v = -\frac{x}{dE}\left(l^2 - \frac{l^3}{3l'}\right)$$

and since $l' = \frac{L + l}{4}$, as before,

$$v = -\frac{x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right),$$

Also $v = .00125\ L$ as before, so that

$$L = -\frac{800x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right),$$

which is the same equation that was deduced when *x* was less than *l'*. Since it is the numerical value of the deflection and of the lengths that concern the present problem, the minus sign may be omitted and the equation written:

$$L = \frac{800x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right),$$

Since the equation:

$$v = \frac{x}{dE}\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right)$$

is the equation of the curve to which the center line of the beam conforms, it is to be expected that it will show a point of flexure when *l* is made equal to $\frac{L}{3}$. At the point of flexure the tangent to the curve passes through a maximum, the tangent being $\frac{dv}{dl}$. In the equation, *L* is a variable, but *L* + *l* is constant, so that

$$\frac{dv}{dl} = \frac{2x}{dE}\,l - \frac{4x}{dE}\,\frac{l^2}{L + l},$$

which is the general expression for the value of the tangent. The differential coefficient of this tangent with respect to *l* becomes zero when the tangent is a maximum, that is:

$$\frac{d^2v}{dl^2} = \frac{2x}{dE} - \frac{8x}{dE}\left(\frac{l}{L + l}\right) = 0,$$

which, being solved for *l*, gives

$$l = \frac{L}{3},$$

as was to be expected.

The coefficient $\frac{800\ x}{dE}$ has a definite value for each size of pipe. For 8-in. pipe it is .05007, so the relation between *L* and *l* is expressed by the equation:

$$L = .05007\left(l^2 - \frac{4}{3}\,\frac{l^3}{L + l}\right).$$

In using the equation, values may be assumed for *L* and the corresponding values of *l* computed. This requires the solution for a cubic equation in each case and the computation is simpler if *L* is calculated from assumed values of *l*. If, for instance, *l* be made 100 ins., the corresponding values of *L* are 353 ins. and 47 ins., either of which values satisfies the equation, but the latter value cannot be used, for it is less than the minimum value; that is, the expansion of the arm 100 ins. long would overload the short arm if it were but 47 ins. long.

If *l* is made equal to *L* in the last equation, when both arms make a complete reverse curve, we have:

L = l = 60 ins.,

and this is a critical value. If the arms are of equal length and are made shorter than 60 ins., they will be loaded to a greater amount than 16,000 lbs. per square inch. If one arm is made shorter than 60 ins., it is possible to calculate a length for the other which will take care of the expansion in the arm of assumed length, but the calculated arm will have a length too great to allow of its expansion being cared for by the deflection of the other. In the general equation the deflection is calculated for one-half of the beam, and l cannot be greater than L. If a value of L less than 60 ins. is assumed, the calculated values of l will be found to be either impossible or imaginary. If, for instance, L be 30 ins., the equation for 8-in. pipe becomes

$$l^3 - 90\,l^2 + 1800\,l = -54{,}000,$$

which must give three values for l. When solved, one value is — 15.66 and the other two are imaginary in solving the square root of a negative quantity, and — 15.66 ins. is an impossible length, because L and l must have the same sign.

It is to be expected that with a given length of branch pipe greater than the limiting length, the length of the main will be longer when the branch is at the end of the line than when it is in the middle of a long run, for part of the bending is in the main itself. The equation shows this, for if the calculation be made for 8-in. pipe an end branch of 100 ins. length allows the main to be 353 ins. long, while a 100-in. branch in the center of a run will care for a length of 167 ins.

Each size of pipe has its limiting length when connected as shown in Fig. 1, and it is found from the equation above. For 14-in. standard weight pipe it is 108 ins.; for 10-in., 75.25 ins.; 6-in., 46 ins.; and this length decreases rapidly as the size decreases. One-inch pipe has 8.75 ins. as its limiting length, and ⅛-in. pipe has 2.65 ins., and if these length are decreased, either the hub or flange to which the pipe is attached springs more than is expected or the pipe is overloaded, both branches being erected at the same temperature. It is of course possible, but very unusual, to lessen the stress in one branch by having a negative stress in the other when cold, that is, cutting one arm a little short, and the stress in each arm can be halved by making them both short.

THE USE OF FUEL OIL IN CALIFORNIA.

BY J. R. CRAVATH.

The extensive discovery of fuel oil in California has proved a great blessing to the power-consuming industries of that state. There are no extensive or adequate coal mines within 1000 miles of central and southern California, where the greatest amount of power is used, and the conditions are such that freight is very high. Much coal has been imported from foreign countries by being taken as a return cargo on ships sailing out of San Francisco. Coal is now worth from $8 to $12 a ton, though a few special users controlling coal mines can get it for less.

Oil was discovered and used as much as ten years ago in California, but it is only recently that the extent of the oil fields in the state was realized. The price is, of course, going down, as new fields and wells are opened up. What the price of oil now is it is impossible to say, as it is extremely variable and depends much on locality. The largest fields are at Bakersfield and are comparatively new; around and in Los Angeles the wells are older. Many large fuel users in Los Angeles own their own wells. It has been stated to the writer by one interested in some of these wells that the cost of production, even where the oil has to be pumped, is not over one cent a gallon. Others maintain that it cannot be put on the cars for less than 4 cents a gallon, counting all expenses. The cost per barrel in San Francisco is from 90 cents to $1.25.

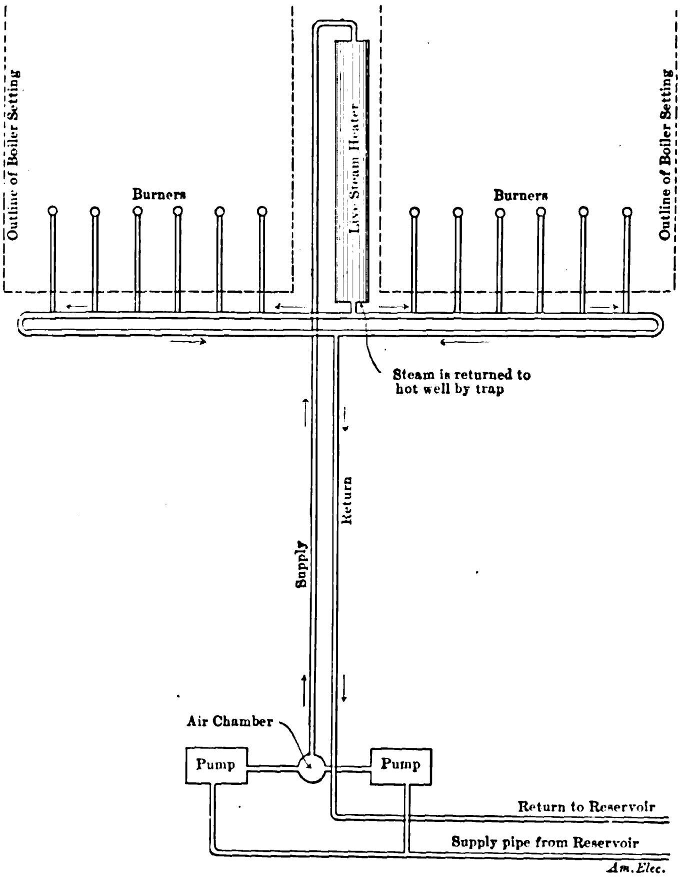

Outline of Boiler Setting
Burners
Live Steam Heater
Burners
Outline of Boiler Setting
Steam is returned to hot well by trap
Supply
Return
Air Chamber
Pump
Pump
Return to Reservoir
Supply pipe from Reservoir
Am. Elec.

FIG. 1.—DIAGRAM OF CONNECTIONS FOR OIL BURNERS.

Most of the California oil is thick and heavy, and has asphalt as a base. It is fit for nothing but burning crude as a fuel, as it cannot be refined. Its specific gravity may be anywhere from 12° to 20° (water being 10°), though most of the oil used is in the neighborhood of 16°. When the specific gravity closely approaches that of water, it is with difficulty that it is separated from water. The oil seems to form globules around the water, which settle very slowly. To overcome this difficulty slight agitation, together with settling, is employed. The oil is so thick that it can be pumped only through pipes of large diameter, unless heated to make it run freely; consequently all the steam plants using oil as a fuel make provision for heating it before it passes to the burners, not only to facilitate pumping, but to make its vaporization at the burner easier. The San Gabriel Electric Company at Los Angeles found that by heating the oil to 212° Fahr. instead of 110° as formerly, it could make a saving of 4 per cent in fuel consumed per kilowatt-hour. This is accounted for mainly by the smaller amount of steam required to atomize the oil and the more perfect combustion obtained when the oil is thin.

It is customary to consider roughly that 3¾ barrels of oil are equivalent to one ton of coal, but, of course, this figure depends much on the kind of coal and oil. One thoroughly modern plant in San Francisco, containing Babcock & Wilcox boilers and large McIntosh & Seymour vertical compound condensing engines, develops 120 kilowatt-hours per barrel of oil. This is probably as good an efficiency as could be counted on. The Oakland Transit Company evaporates 13 lbs. of water per pound of oil in the actual operation of the plant. The oil is from 16° to 17° specific gravity. The burner used is made by the Wilgus Manufacturing Company, of Los Angeles, and is the one most extensively used for oil burning on the Pacific Coast, as it has been devised especially to burn California oils. A steam jet emerges from the burner in the shape of a fan, and the oil is delivered on top of the jet. One-third more capacity is being obtained from the Oakland Transit Company's boilers than with coal.

A diagram showing the principle upon which the piping is arranged in the Oakland Transit power house is given in Fig. 1. The oil is drawn from a storage reservoir by one of a pair of old boiler feed pumps, passes to a live steam heater between the two banks of boilers, and through the heater to the burners. To prevent air from getting into the burners through having a dead end in the burner supply pipe a small return pipe goes from the burners back to the storage reservoir. The grates formerly used for coal are loosely covered with firebrick, and just enough air is admitted to make the combustion smokeless, but no more.

The recent discovery in Texas of oil similar in many characteristics to the California oils, makes the consideration of oil burning of interest to more engineers in the United States than formerly.

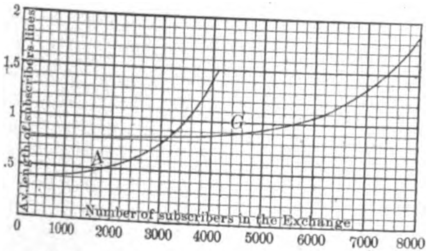
TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

SUBSCRIBERS' LINES AND TRUNK LINES.

In speaking of the length of a subscriber's line, the distance of the subscriber from the office along the route traversed by the line is taken as the length, and not the actual length of wire that may be in the circuit. In order to determine the average length of subscribers' lines in an exchange with absolute accuracy, it is necessary to take actual measurements from a map. An average figure, however, is very useful as a guide. The curves in Fig. 1 represent the average figures for twenty-five American cities having exchanges of from 200 to 4000 subscribers each, and a similar number of German cities having exchanges of from 200 to 8000 subscribers each. The curve for the American cities is indicated by the letter *A*, and the curve for the German cities by the letter *G*.

It will be seen that the average length of subscribers' lines in American cities of from 200 to 1000 subscribers is 0.4 circuit-mile, the maximum in this range about 0.6, and the minimum about 0.25 circuit-mile. In comparing the curve taken from the German exchanges with that taken from the American exchanges, it should be remembered that in Germany all lines are still aerial and house-top construction is used. One would expect, therefore, that the German curve would lie below the American curve, but this is true only for exchanges having more than 3200 subscribers. The reason for German cities of less than 3200 subscribers showing a longer average length for the subscribers' lines may be that in these cities the residence and business premises are not separated to the same extent as in American cities; many storekeepers live above their stores, and a lawyer or physician has his office at his home, so that the telephones are more evenly distributed over the territory supplied by the exchange in Germany than in this country. The average length of subscribers' lines in exchanges having less than 200 subscribers throughout America would probably be found to be about half a circuit-mile; data from several hundred exchanges in Germany gave an average length of about one circuit-mile.



Am. Elec.

FIG. 1.—CURVES SHOWING LENGTH OF SUBSCRIBERS' LINES.

The length of a trunk line depends, of course, upon the location of the offices of the exchange. In order to provide the best possible service in an exchange having more than one office, each office must be connected to each of the other offices by a number of trunk lines sufficiently large to enable the maximum probable number of connections to be made promptly. Such an arrangement is known as an "interlacing" trunk line system. In some cases one trunk line has been made to serve several offices, a call being trunked from the originating office to an intermediate office and then re-trunked from that office to the one to which that subscriber is connected. This effects some economy in trunk lines, but is not a good policy where rapid service is desired.

As stated in a previous article, there are two classes of trunk lines, "outgoing" and "incoming," and each "outgoing" trunk line from a given office is an "incoming" trunk line at the office to which it extends. In order to determine the number of outgoing trunk lines required for any one office, it is necessary to estimate the number of trunk-line calls that will be made per day. Experience has shown that a trunk line can accommodate an average of 110 trunk calls a day, so that if the number of probable outgoing trunk calls is known, the number of outgoing trunk lines is ascertainable by dividing the probable number of calls by 110.

The percentage of subscribers' calls that necessitate trunking is found by means of the formula:

$$0.75\,\frac{C-c}{C}\ldots\ldots\ldots\ldots(1)$$

in which *C* is the average number of calls made on the entire exchange per day, and *c* is the average number of calls per day for the one office under consideration. The result of this formula gives the proportion of the total number of daily calls, *c*, that will require trunking. Consequently, the probable actual number of outgoing trunk calls from the one office whose daily calls are represented by *c* may be ascertained by means of the formula:

$$0.75\,\frac{C\,c-c^2}{C}=\text{Tc}$$

which may also be written:

$$0.75\left(c-\frac{c^2}{C}\right)=\text{Tc}\ldots\ldots\ldots(2)$$

As stated above, each trunk line can carry 110 calls per day, so that the theoretical number of trunk lines required for the office having the daily number of calls represented by *c* would be obtained by dividing the result of the above formula by 110. It is advisable, however, to add a few trunk lines as a factor of safety, and it has become customary to add 0.8 trunk line for each office. Thus, if an exchange contains *n* offices, 0.8 (n — 1) trunk lines should be added. This gives as the final expression for the number of outgoing trunk lines required for each office the following:

$$\text{Tl}=\frac{0.75\left(c-\frac{c^2}{C}\right)}{110}+0.8\,(n-1)$$

This formula may be made a little more convenient of application by writing it as follows:

$$\frac{0.75\left(c-\frac{c^2}{C}\right)+88\,(n-1)}{110}=\text{Tl}\ldots(3)$$

Tl being the required number of outgoing trunk lines for an office having *c* daily calls in an exchange having a total of *C* daily calls.

For example, suppose an exchange has two offices, one of which has 1200 daily calls and the other 800 daily calls. The total daily calls for the exchange would, therefore, be 2000. In such a case the value of *c* for the larger office would be 1200; the value of *C* would be 2000; the value of *n* would be 2; and substituting these values in formula (3) would give:

$$\frac{0.75\times\left(1200-\frac{1{,}440{,}000}{2000}\right)+88\,(2-1)}{110}=4.07$$

As it is manifestly impossible to have a fractional number of lines, 4 would be the number of outgoing trunk lines for the larger office. The value of *c* for the smaller office being 800, substitution in the formula would result as follows:

$$\frac{0.75\times\left(800-\frac{1{,}440{,}000}{2000}\right)+88\,(2-1)}{110}=1.34$$

outgoing trunk lines for the smaller office. In this case 2 lines would be installed.

In all modern exchanges having more than one office, the orders for trunking are transmitted between the offices over separate "order-wires" which connect the operator's telephone sets at one office with the operator's sets at the other offices. Experience has shown that one order-wire circuit is required for every 20 outgoing trunks; in the case of the small exchange just assumed, only one order-wire circuit would, therefore, be necessary each way between the two offices.

◆

American Generating Units for a Swedish Lighting Plant. — American engineering for central station and isolated electric lighting is gradually being accepted as standard practice throughout European countries, and this growing familiarity with the methods employed in this country has created a constantly increasing demand for representative American machinery. A recent contract of special interest illustrating this point provides for generating units for a new electric light and power plant at Stockholm, Sweden, comprising two 250-h.p. Westinghouse vertical cross-compound engines, direct-connected to two Westinghouse generators. The generator armature is to be mounted on the engine shaft; the engine bearings are to be adjustable from the lower side so as to preserve alignment with the outboard bearing, and many other features that are commonly found in American lighting plants will be introduced in this station.

An English Electric Railway Engine.

Among the very interesting steam engines exhibited in Machinery Hall at the recent Glasgow International Exhibition was a 700-h.p. horizontal cross-compound engine designed and built by Davey, Paxman & Co. especially for driving a direct-current railway generator; the armature of the generator was mounted on the shaft between the two cranks, as shown in Fig. 7, herewith, which is reproduced from the London *Engineer*. The cylinders are 15½ ins. and 27 ins. in diameter respectively, with a common stroke of 30 ins. No cylinder jackets are provided, because the engine was designed to use steam superheated to 650° Fahr. Notwithstanding the use of superheat, however, an intermediate reheater is provided between the cylinders, through the tubes of which live steam direct from the boiler is passed. The engine was designed also for use in connection with a surface condenser, but no facilities were available at the exhibition for condensation so that it was operated non-condensing.

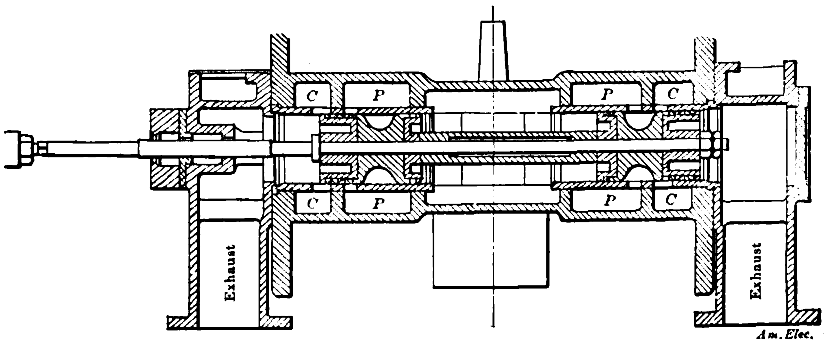


FIG. 1.—HIGH-PRESSURE MAIN VALVE.

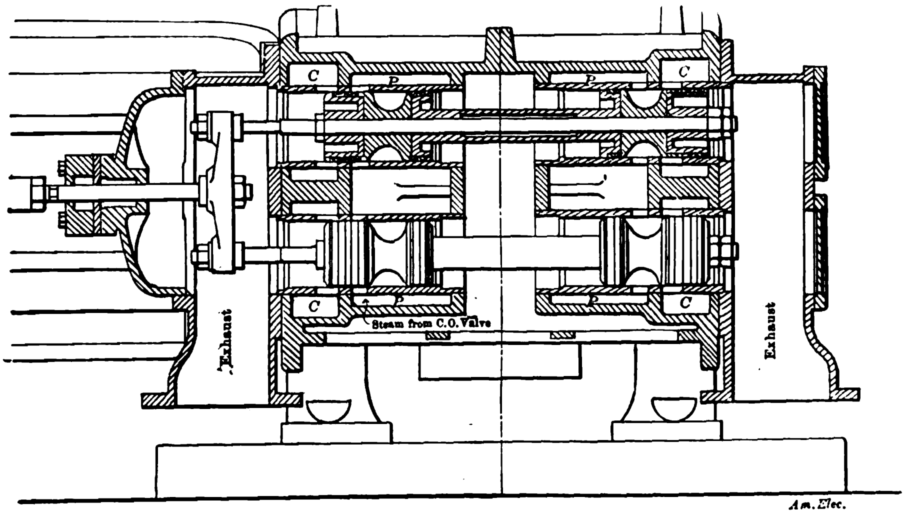


FIG. 2.—LOW-PRESSURE MAIN VALVE.

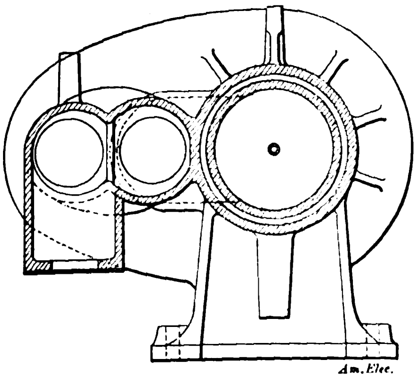


FIG. 3.—TRANSVERSE SECTION OF HIGH-PRESSURE CYLINDER.

The valve gear is somewhat elaborate. Each cylinder is provided with a main valve of the piston type and an auxiliary cut-off valve, also of the piston type. Fig. 1 is a cross-section through the high-pressure main valve and steam chest, and Fig. 2 is a similar cross-section through the low-pressure main valve, which, as the engraving shows, is a sort of duplex arrangement, there being two distinct valves driven from a single rod through the medium of a cross-head to which the individual valve stems are attached. The main valves are, of course, driven by fixed eccentrics, and the cut-off valves are driven also by fixed eccentrics, but through the medium of adjustable links controlled by the governor. Figs. 6 and 5 are cross-sections through the high- and low-pressure cut-off valves, respectively, and Figs. 3 and 4 are transverse sections of the high-pressure and low-pressure cylinders and steam chests, respectively. The chests are provided with cast-iron liners or valve seats of the multiport type, so that the valve is really a combination of the piston and gridiron principles.

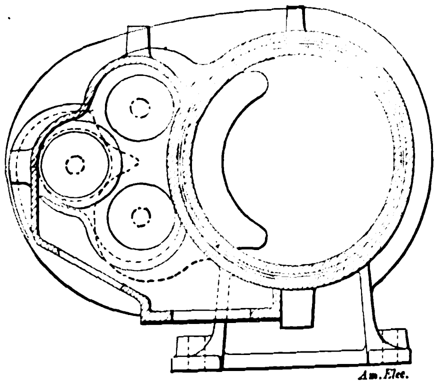


FIG. 4.—TRANSVERSE SECTION OF LOW-PRESSURE CYLINDER.

Steam enters in the center, as indicated in the engraving, and passes through the ports, *P P P P*, Fig. 1, for distribution by the main valve, which connects the ports, *P*, with the ports marked *C*, the latter leading to the cylinder, of course. In Figs. 3 and 4 the valve chambers nearest the cylinder are those of the main valve, and the chambers farthest away are those in which the cut-off

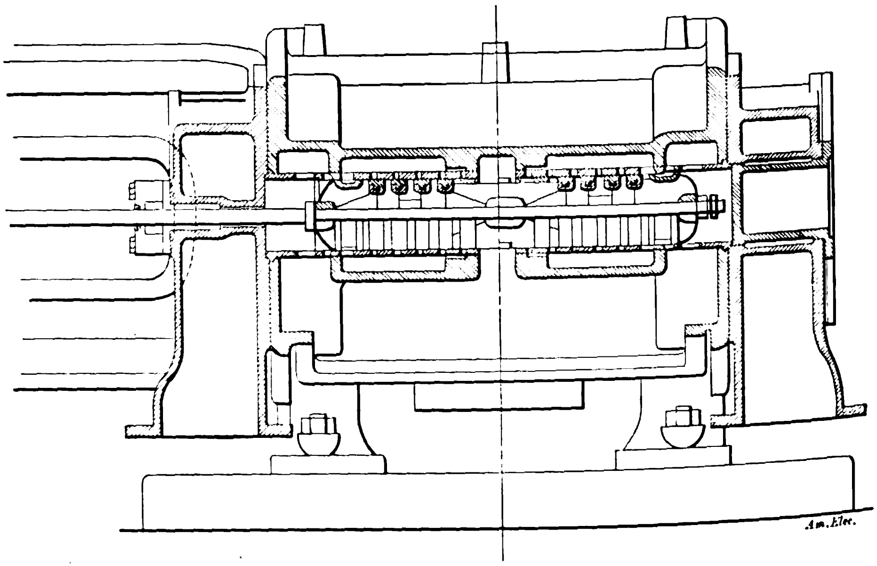


FIG. 5.—LOW-PRESSURE CUT-OFF VALVE.

valves operate. The passage of steam through the low-pressure valves is, of course, the same in general as through the high pressure valves. The main

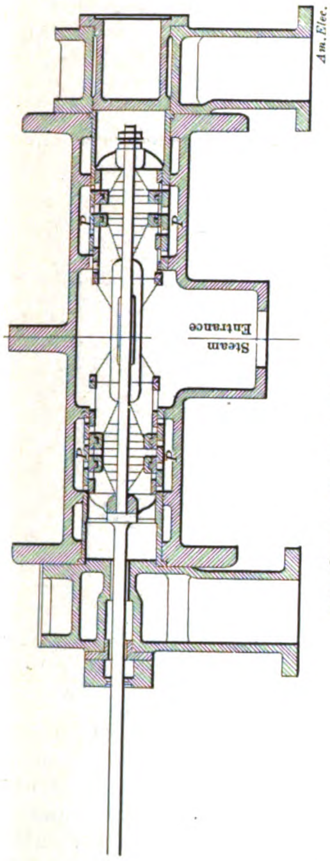


FIG. 6.—HIGH-PRESSURE CUT-OFF VALVE.

valves control the exhaust as well as the admission, exactly like the valve of a single-valve engine.

It will be noticed that the stems of the main valves are enclosed by sleeves between the two halves of each valve, so that the superheated steam does not come in contact with them. The stem of the high-pressure cut-off valve is subject to the direct influence of the superheated steam, but this could be avoided by making the outer ends of each half of the valve solid, so as to prevent the steam from passing entirely through the valve, the steam being covered by a sleeve along its central portion, like the stems of the main valves.

All of the valves are 7½ ins. in diameter. The high-pressure cut-off valve has four port openings, each ½ in. wide, and the high-pressure main valve has one port opening on each side of the partition 2 ins. wide. The low-pressure cut-off valve has six port openings, each ½ in. wide, and the low-pressure main valve has ports 2 ins. wide; as this is a duplex valve, the effective area of the low-pressure port openings is twice that of the high-pressure port openings. The calculated steam velocity through the ports is

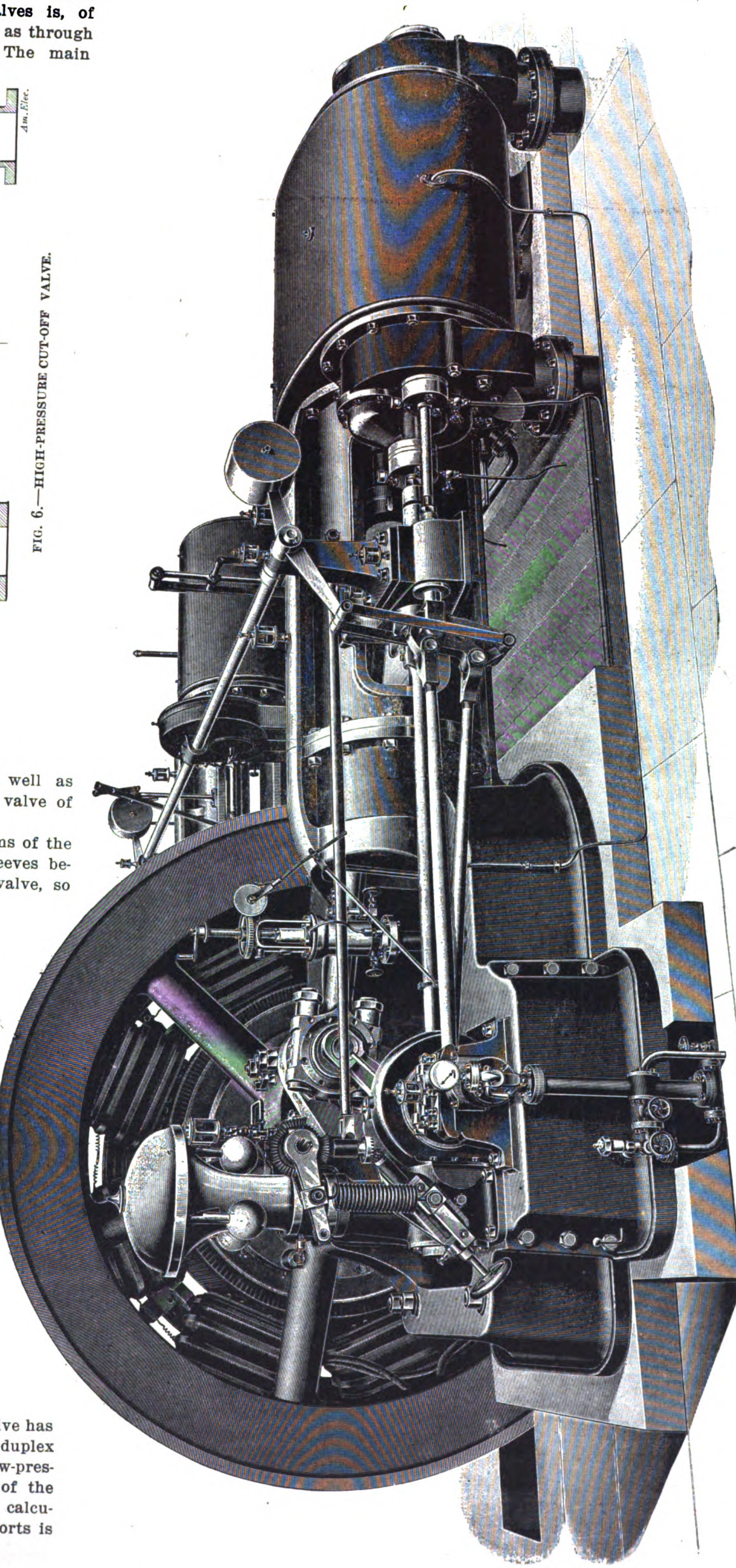


FIG. 7.—CROSS-COMPOUND DAVEY, PAXMAN 700-H.P. ENGINE DIRECT-CONNECTED TO RAILWAY GENERATOR.

about 4500 ft. per minute. All of the valves, like their seats, are of cast iron.

The governor is of the fly-ball type, with three balls. The outward movement of the balls lifts the case, the motion of which is opposed by its own weight, of course, and also by a strong spiral spring, shown in Fig. 7. The governor is located on the low-pressure side and is driven through bevel gears from the main shaft. The governor gear on the low-pressure side is connected with that on the high-pressure side in the usual manner by a rock shaft. The travel of the cut-off valve is controlled by the link, which is adjusted by the governor in the well-known manner.

The generator is an 8-pole compound-wound machine of the usual type built for railway service, and was built by the Electric Construction Company. The normal speed of the unit is 150 r.p.m., and the normal steam pressure is 160 lbs. per square inch. An automatic lubricating system is used, the distributing pump being plainly shown in Fig. 7.

Fan Motors for 1902.

The high development to which both the direct-current and alternating-current fan-motors have been brought renders it

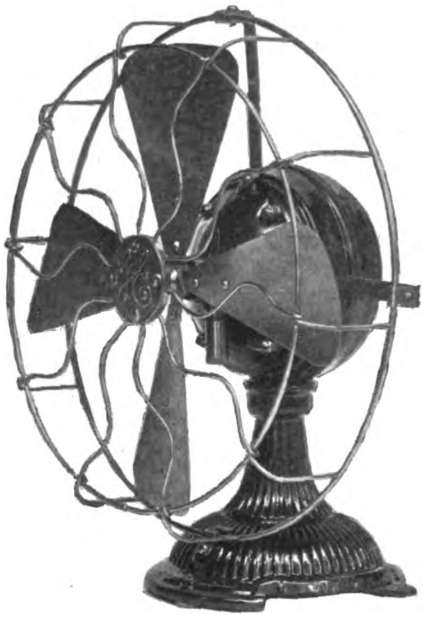


FIG. 1.—G. E. DIRECT-CURRENT DESK FAN MOTOR.

too much to expect this season any conspicuous improvements in the design of the motor proper. These little machines, which were at first little more than toys, have been perfected to such a degree that a motor incapable of performing unfailing service throughout at least one season without attention, and with reasonable efficiency, cannot be kept on the market at any price

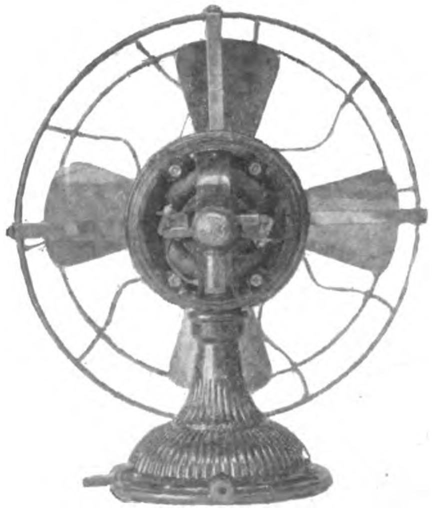


FIG. 2.—REAR VIEW OF G. E. DESK FAN MOTOR.

The fan motors of the General Electric Company for this year embody all of the good points which were incorporated in their design last year, only slight changes in the way of mechanical improvement having been made. The casing of the direct-current desk-fan motor has been modified into an almost spherical shape, as indicated in Fig. 1, which illustrates the 12-in. swivel frame fan. Fig. 2 is a rear view of the same machine, with the enclosing cap removed, to show the brush-holders and field-magnet coils. The brush-holders are of the finger-feed type, which met with so much favor last year and the year before, but the mechanism has been modified somewhat to make it simpler and more compact. The field magnet is built up of sheet steel, and provided with form-wound coils, as indicated in Fig. 3, and the bolt holes through the field-magnet structure are oval instead of round, in order to allow adjustment for any slight discrepancy in the polar axis through the armature, the brush-holders being mounted stationary on the frame. The armature is of the usual slotted-drum type, with the slots crossing the core diagonally, as illustrated in Fig. 4. The commutator has been given greater wearing surface than heretofore, but otherwise this part of the machine remains unchanged.

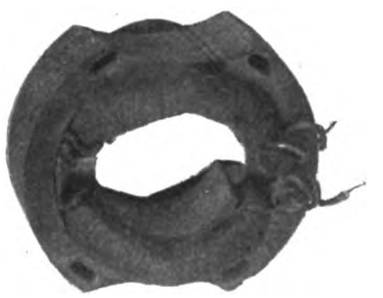


FIG. 3.—G. E. FIELD STAMPINGS AND COILS.

Fig. 5 illustrates this form of motor with spring suspension. In this form the fan is made 10 ins. in diameter. The desk-fan motors are built in 12-in. and 16-in. sizes, and are also built with trunnion adjustment in addition to the swivel adjustment of the frame. In these motors bracket mounting is also provided, as usual; Fig. 7 illustrates the bracket form of machine, with both swivel and trunnion adjustment.

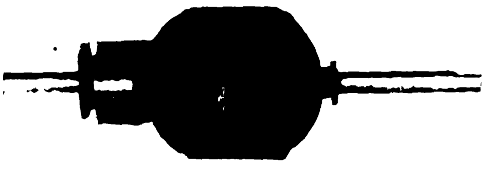


FIG. 4.—G. E. DIRECT-CURRENT FAN MOTOR ARMATURE.

All of the machines are fitted with variable-speed switches, and finished in black enamel, with polished-brass fans, guards and trimmings.

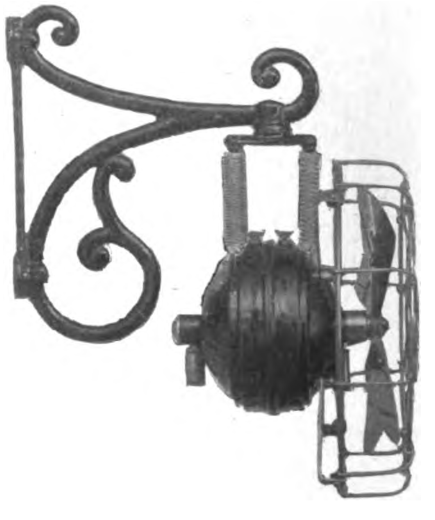


FIG. 5.—G. E. SUSPENSION FOR SMALL FAN MOTORS.

Fig. 6 illustrates one of the few new fan designs that have been brought out this year. This is a banquet-table and reading-table fan, designed to distribute a gentle breeze over a considerable area below the fan proper. The distribution of air is accomplished by means of the deflecting plate immediately below the fan. This machine is provided with an 8-in. fan, and stands 24 ins. high over all. The motor is a direct-current machine, built for 115 volts, and is provided with a three-speed switch. The casing is extremely artistic, being finished in streaked oxidized silver.

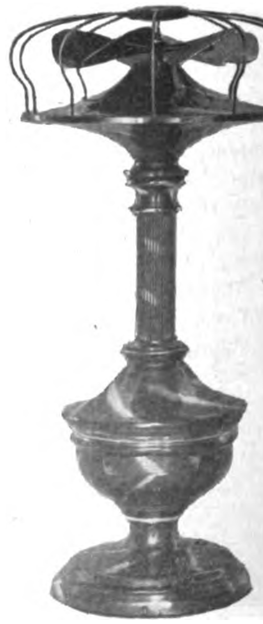


FIG. 6.—G. E. BANQUET AND READING TABLE FAN MOTOR.

The General Electric Company's alternating-current fans are practically identical with those of last year, an ordinary squirrel-cage armature being employed in connection with a four-pole field magnet equipped with shading coils or straps (see Fig. 8.) Fig. 9 is a front view of one of these machines in the 12-in. size, equipped with a swivel base. They are built also with 16-in. fans and with trunnion adjustment in addition to the swivel.

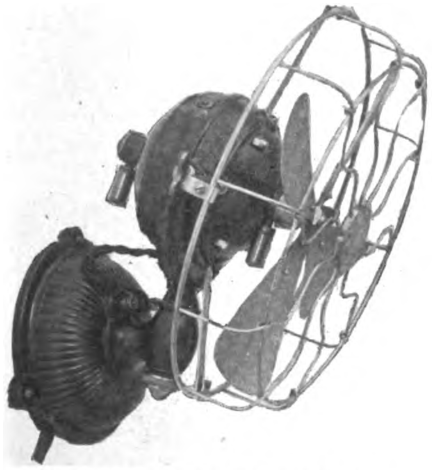


FIG. 7.—G. E. BRACKET FAN MOTOR.

The motor of the General Electric ceiling fan, Fig. 10, is of the usual multipolar type, and drives a four-blade fan having a 58-in. sweep. The fan switch is mounted in the bottom of the structure, and the thumb piece projects below the center of the blades. The casing is finished in either black enamel or oxidized copper.

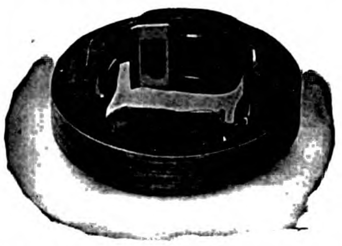


FIG. 8.—G. E. ALTERNATING-CURRENT FIELD.

A new line of machines this year is that of the Fort Wayne Electric Works, Fort Wayne, Ind., the desk type of which is illustrated by Fig. 11. Fig. 12 is a view of the field magnet and coils, which shows that the construction of this part of the machine is very similar to that of the General Electric direct-current fan-motor. The armature, Fig. 13, is also similar, the core discs being twisted so as to make the slots cross the core diagonally. Carbon brushes of rectangular cross-section are used, and are mounted in brass tubes, into which they fit closely. The brushes are pressed against the commutator, of course, by springs, and these are contained in the tubes immediately back of the brushes, as in the ordinary cartridge type of brush-holder. The spring tension, however, is adjustable by means of screws in the back ends of the brush-holders, which is a feature not commonly provided. The bearings are of course self-oiling. The power consumption is 17 watts.

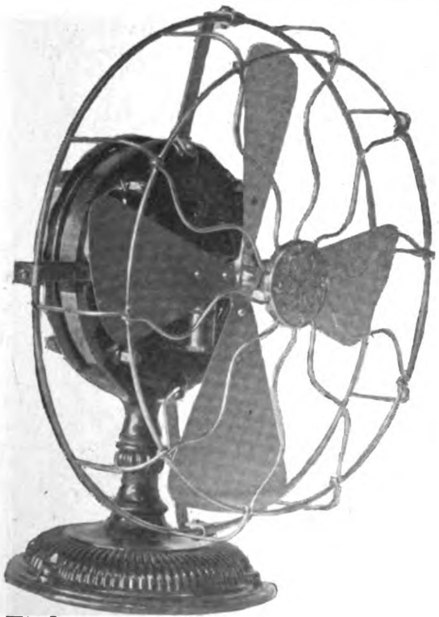


FIG. 9.—G. E. ALTERNATING-CURRENT DESK FAN MOTOR.

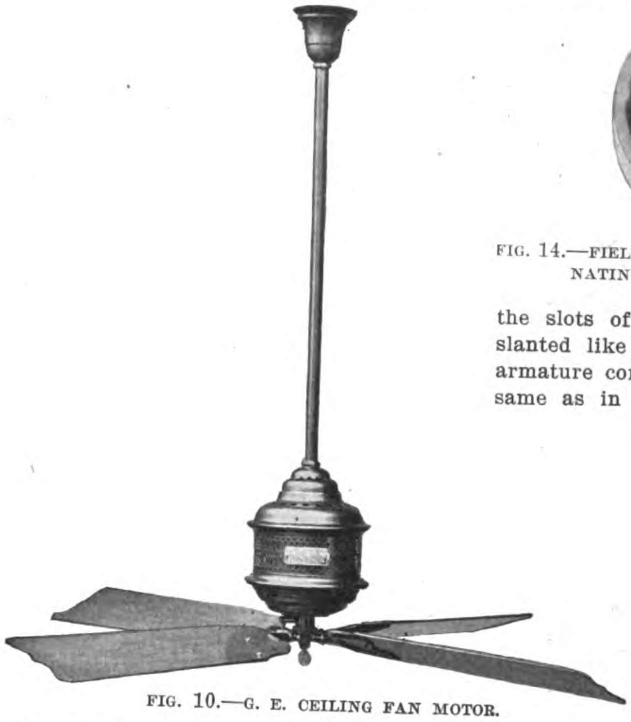


FIG. 10.—G. E. CEILING FAN MOTOR.

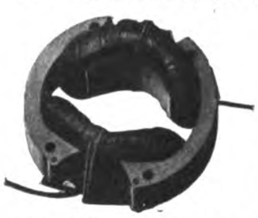


FIG. 12.—FIELD MAGNET AND COILS OF FT. WAYNE DIRECT-CURRENT FAN MOTOR.

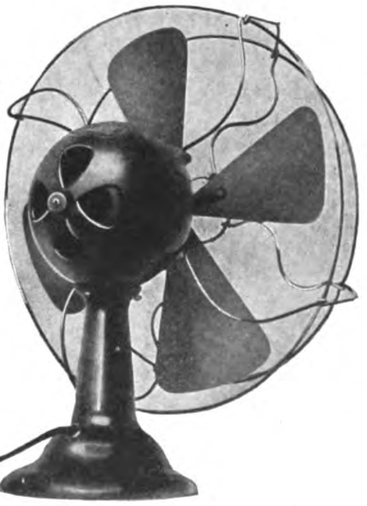


FIG. 11.—FT. WAYNE DIRECT-CURRENT DESK FAN MOTOR.

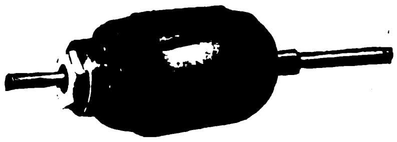


FIG. 13.—ARMATURE OF FT. WAYNE DESK FAN MOTOR.

The Ft. Wayne alternating-current fan motor is of the induction type, provided with a four-pole field magnet, illustrated by Fig. 14, and a squirrel-cage armature, Fig. 15. It will be noticed that the slots of the squirrel-cage core are slanted like those of the direct-current armature core; the object of this is the same as in the direct-current machine, *i. e.*, to prevent humming. These machines are all provided with 8-in. fans, and run at a maximum speed of 2200 r.p.m. The power consumption is as follows: 50-volt motor, 17 watts at 60 cycles, and 36 watts at 140 cycles; 104-volt motor, 17 watts at 60 cycles and 36 watts at 140 cycles. The body of all of the motors is unusually small, the spherical

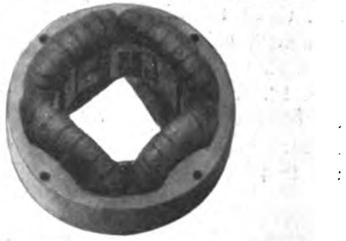


FIG. 14.—FIELD MAGNET OF FT. WAYNE ALTERNATING-CURRENT FAN MOTOR.

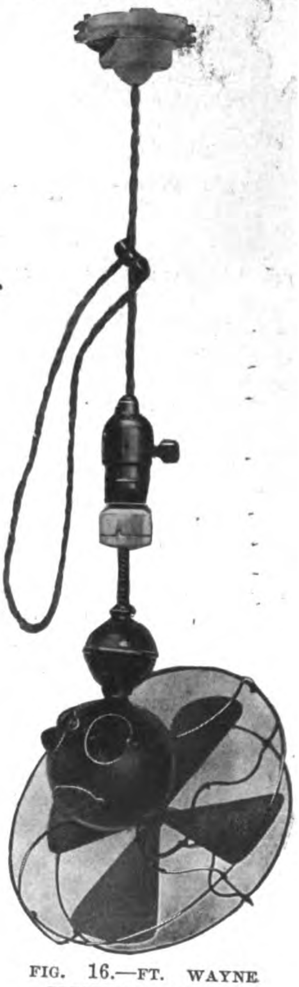


FIG. 16.—FT. WAYNE REVOLVING FAN MOTOR WITH CORD SUSPENSION.

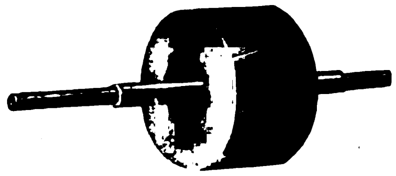


FIG. 15.—ARMATURE OF FT. WAYNE ALTERNATING-CURRENT FAN MOTOR.

casing being only 3⅝ ins. in diameter. The casing is made of aluminum, in order to reduce the weight of the machine.

In addition to the usual form of mounting, these machines are mounted on ornamental columns, and are also provided with cord suspension, as indicated in Fig. 16. The machine shown in this latter engraving also possesses the unusual feature of being self-revolving. The motor is pivoted to the ball just above it, and the position of the machine is such that the shaft of the motor is at an angle of 45° with the vertical axis of the complete structure. The result is that the top of the fan blades being further from the center of rotation than the lower blades, an unbalanced condition is produced, which causes the motor to revolve. The pivot on which it revolves is a ball bearing.

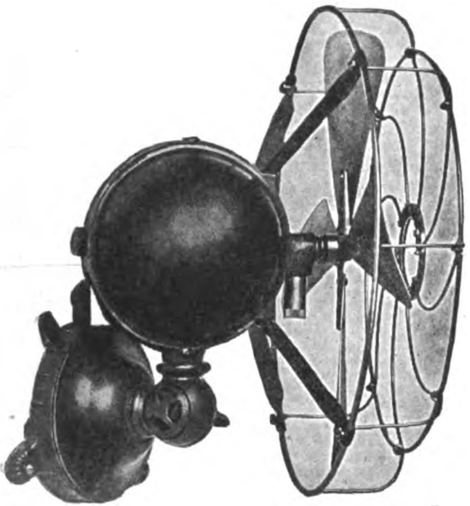


FIG. 17.—JANDUS BRACKET FAN MOTOR.

Another new fan motor this season is the one made by the Jandus Electric Company, Cleveland, Ohio, and illustrated by Figs. 17 and 18. Fig. 18 shows the construction of the machine very clearly. The field magnet is of the laminated bipolar type, very similar to that of the Fort Wayne and General Electric machines just described, and the enclosing caps are of such form as to give the motor a spherical shape when it is completely assembled, as indicated in the illustration of the bracket fan, Fig. 17. The reason for building the field structure as shown in Fig. 18 was to insure perfect rigidity and permanent alignment between the two bearings. These being mounted in a single frame, it is obviously impossible for them to get out of alignment unless the frame is damaged by some severe treatment. As a close inspection of the engravings will show, the same mounting serves for both the desk and the bracket fan; the bracket arrangement being obtained by turning the base upward through an angle of 90°. The brushes and holders are of a modified cartridge type, and the holders are secured to the frame, of course, through insulating bushings and plates. It will be obvious that the protecting casing may be removed while the motor is running, giving complete access to all of its parts without disturbing any active part of the machine. This construction also results in the entire enclosure of all current-carrying parts; the connections to the motor are led through the pedestal, and the terminal posts are beneath the base, where the rheostat and switch are also located. Three speeds are provided, namely, 800, 1200 and 1600 r.p.m., and the machines are wound for 110-volt and 220-volt circuits. The bearings are provided with the familiar form of wick lubrication from beneath.

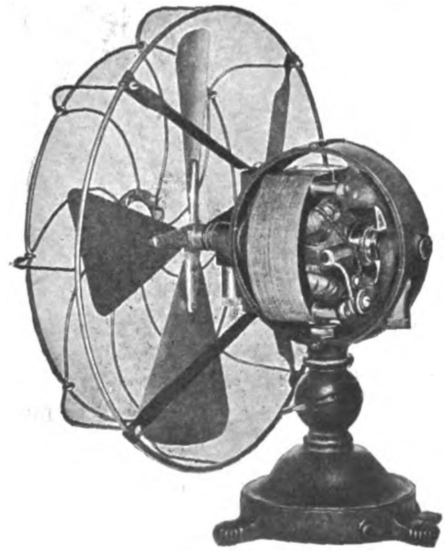


FIG. 18.—JANDUS DESK FAN MOTOR.

Still another novelty is presented this season in the "Comfort" oscillating fan, illustrated by Figs. 19 and 20, and built by the Shedd Electric & Manufacturing Company, New York City. The motor is pivoted on a ball bearing so that it can oscillate around its vertical axis through any desired part of the circle up to about 240°. The fan guard carries vertical vanes, as shown, these being pivotally mounted at each end and connected together by a link at the bottom. With these vanes set obliquely in front of the fan, the draft of air from the fan blades causes the motor to turn on its pivot until it comes to the end of its travel in that direction. At this point the finger which is shown extending from the base and turning upward near the center vane comes in contact with an adjustable post on the base of the machine, and shifts the vanes to a similar angle in the opposite direction. This reversal causes the motor to swing around in the reverse direction until the finger comes against the other post, at the end of its travel in that direction, when the vanes are shifted back again. The two posts between which the vane-shifting finger travels are adjustable in circular slots around the base of the motor, so that the travel can be limited to any desired extent within the maximum range. The result of this arrangement is, of course, that while the fan is in operation it swings back and forth, distributing the breeze over a much greater area than would be possible with a stationary fan. The speed at which the fan oscillates is adjustable by varying the angle to which the vertical vanes may be turned by the finger; the greater this angle, the more rapid the oscillation, of course.

The machine also embodies some novel features of internal construction. The speed-regulating resistance, instead of being made of fine wire, as is usual, consists of a bar of composition, which, it is claimed, cannot be burned out. The commutator is of the disc pattern, and the brushes, which are carbon pencils mounted in cartridge holders, are therefore parallel with the shaft. The springs feeding the brushes tend to force the armature against the front bearing, and this tendency is practically balanced by the thrust of the fan when it is in operation, so that the armature revolves with the shoulders of the shaft free from the faces of the bearings. While the field-magnet structure is of the usual circular form, the machine is not entirely enclosed, the bearings being mounted in spiders instead of the more usual enclosing caps, so that the operation of the fan blades causes a strong draft through the interior of the machine and provides thorough ventilation. The connecting wires between the armature and commutator are entirely enclosed in an insulating cup, which not only serves to protect them from mechanical injury, but also keeps out moisture.

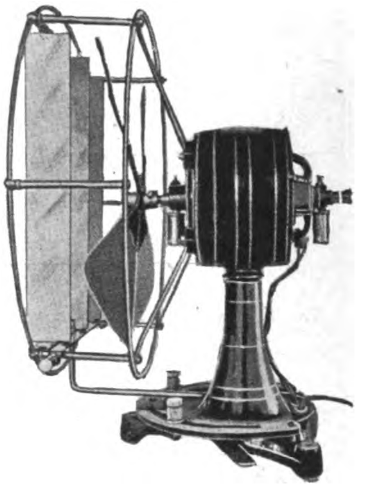


FIG. 19.—"COMFORT" OSCILLATING DESK FAN MOTOR.

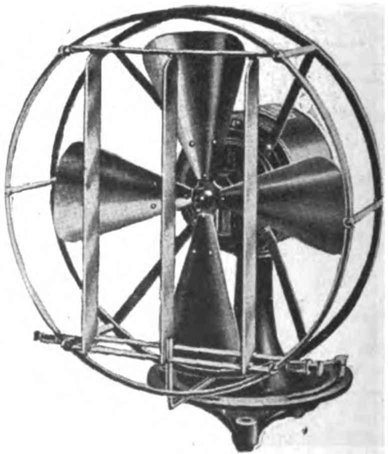


FIG. 20.—"COMFORT" OSCILLATING DESK FAN MOTOR.

The Robbins & Myers Company, Springfield, Ohio, has brought out a new line of desk and bracket fan motors this year. Fig. 21, herewith illustrates the desk motor, and Fig. 22 the bracket style. The motor is a bipolar machine with the usual form of slotted drum armature, but the armature is larger than is ordinarily found in a 12-in. desk fan. The armature and field coils are form-wound and insulated before being placed in position. The brush-holder is of the well-known cartridge type, and each holder is mounted in an insulated clamp on the rear end-cap of the motor, as plainly shown in Fig. 21. The connections are made to the clamps so that the brush-holders and brushes may be removed without disturbing the electrical connections and by simply slacking a single screw on each holder. The brushes are 5/16-in. carbon pencils, 1¼ ins. long, and are fed radially to the commutator by piano-wire compression springs. The commutator is thoroughly insulated with mica, and the connecting wires are securely bound to an asbestos insulating ring on the rear collar of the commutator in order to prevent their being broken by vibration or rough handling of the machine. Another notable improvement in the 1902 fan is the form of bearing used. The bearing sleeve is split lengthwise along the top and fits snugly in the hole drilled through the center of the hub or central projection of the end cap. Two screws are set into the end of the hub at such an angle that setting them up draws the split sleeve more closely around the shaft. This adjustment is provided, of course, for the purpose of taking up wear in the journal sleeve. The journals are lubricated by a wick oiler of the usual under-feed type.

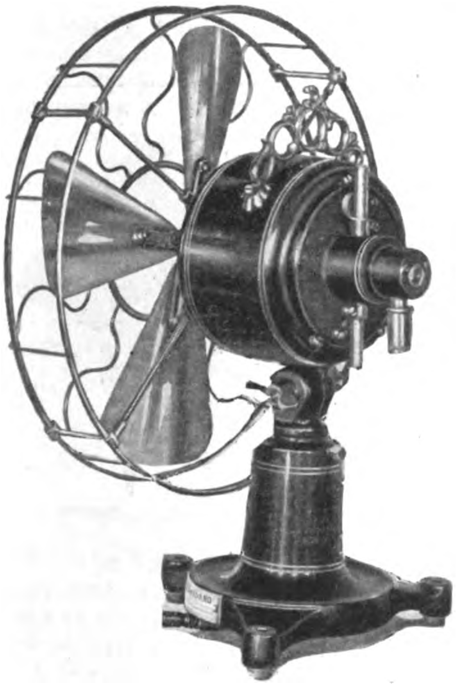


FIG. 21.—ROBBINS & MYERS DESK FAN MOTOR.

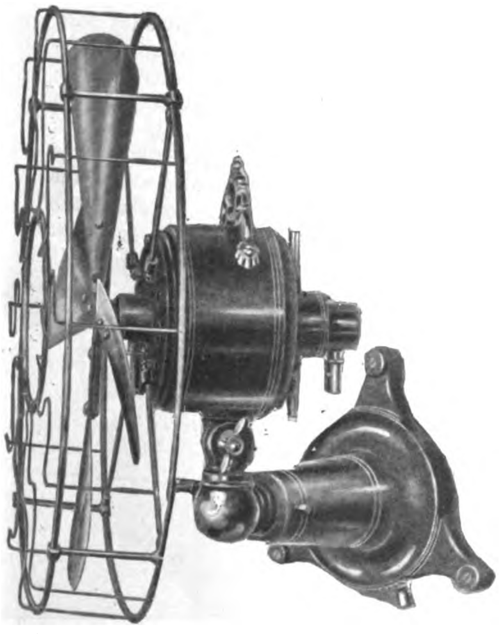


FIG. 22.—ROBBINS & MYERS BRACKET FAN MOTOR.

Universal adjustment for the desk fan is provided in the form of horizontal and vertical swivels, the horizontal swivel being fastened by means of a thumb nut, and the vertical swivel by means of a set-screw near the top of the pedestal. The bracket fan has similar adjustment, but both swivels are tightened by means of thumb nuts. Both forms are provided with three-speed regulating switches, giving 1000, 1400 and 1800 r.p.m. for the 12-in. fan, and 800, 1150 and 1500 r.p.m. for the 16-in. fan; the regulating switch also serves to break the circuit for stopping the machine. The switch parts are insulated with mica, and the resistance wire is wound on a triangular iron frame heavily insulated with asbestos. The power consumption of these machines ranges from 35 to 45 watts for the 12-in. fan, and from 85 to 95 watts for the 16-in. fan, the variation being due to the lack of uniformity in voltage on various circuits of nominally the same voltage. The machines are built for the standard direct-current circuits of 110, 220 and 250 volts. When two or more motors are operated in series, the regulating switches are constructed so that they cannot open the circuit, but the speeds of all of the fans may be regulated, of course, by any one switch, or by two or more in combination.

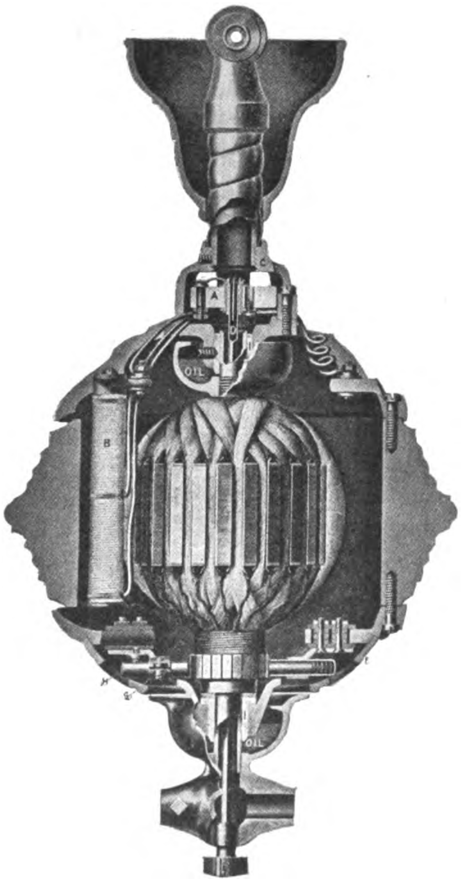


FIG. 23.—SECTION OF ROBBINS & MYERS STYLE B CEILING FAN MOTOR.

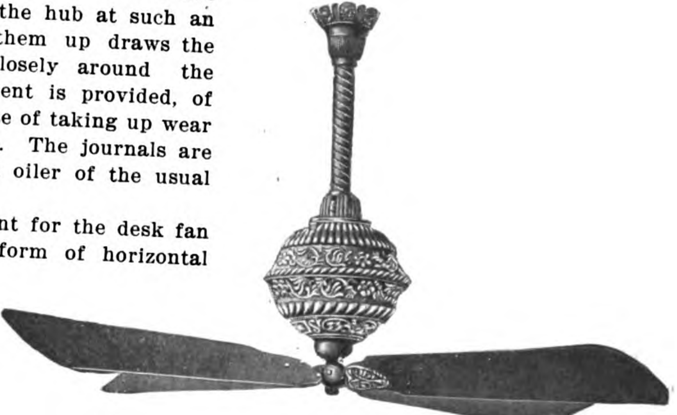


FIG. 24.—ROBBINS & MYERS STYLE B CEILING FAN MOTOR.

The Robbins & Myers ceiling fans for the present season are of the same compact construction which has proved so successful in the past. A cross-sectional view of the Style B fan is shown by Fig. 23, from which it will be evident that the machine is bipolar, and provided with a slot-wound drum armature. Cartridge brush-holders, containing carbon-pencil brushes, are used in these machines, as in the desk form. The armature shaft is hollow, in order to permit the switch spindle, *D*, to pass up through it from the thumb piece, *E*, at the bottom of the fan, to the switch, *A*, at the top. The switch, in conjunction with the resistance coil, *B*, gives three speeds to the

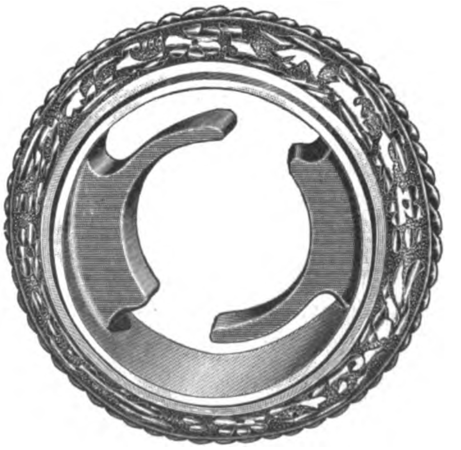


FIG. 25.—FIELD MAGNET STYLE B CEILING FAN MOTOR.

machine. This style of fan (Style B) is not furnished with the switch and resistance unless so ordered, the construction being such that the switch and resistance can be inserted or omitted without changing any of the remainder of the structure. The Style A fan, which is of similar construction, excepting the shape of the field-magnet cores, on the contrary is regularly furnished with this switch. Its full speed is 200 r.p.m., with current consumption of 0.85 ampere at 110 volts. Both machines are furnished ordinarily with four fan blades, and are wound for 110, 170, 220 and 250 volts.

The bearings are lubricated by immersion in two large oil baths or reservoirs, the cups of which are mounted on the armature shaft and revolve with it. The basin or cup at the bottom of the shaft is cast solid with the fan-blade hub, as indicated in the engraving. Fig. 24 is an exterior view of this machine, and Fig. 25 is a view of the field magnet, the construction of which will be obvious by reference to the engraving. A large air-gap is secured by means of the polar extension shown, and at the same time the field poles can be slipped on and off without requiring a separate removable pole shoe.

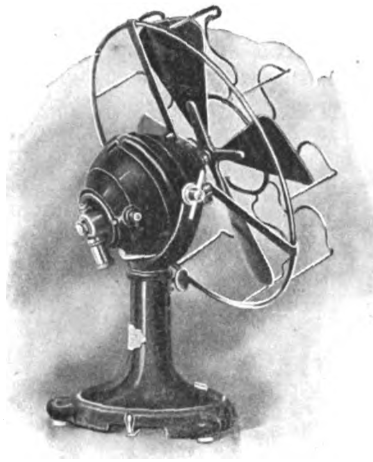


FIG. 26.—LUNDELL DESK FAN MOTOR.

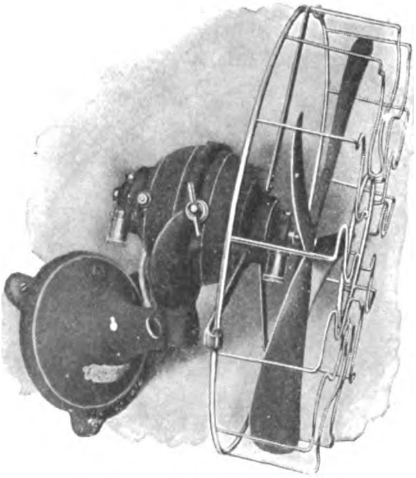


FIG. 27.—LUNDELL BRACKET FAN MOTOR.

In addition to these machines the company has brought out a standard 500-volt fan, which runs at 200 r.p.m. and requires 0.2 ampere at the rated voltage. The general construction is similar to that of the two fans just mentioned, but more room is provided for the windings in order to permit the use of the extra-heavy insulation demanded by the increased voltage.

Fig. 26 represents the Lundell direct-current desk motor as manufactured this year by the Sprague Electric Company. This machine differs from last year's motor chiefly in the mounting, this being of the swivel and trunnion form. These machines are built in 12-in. and 16-in. sizes, and run at three speeds, namely, 800, 1350 and 1900 r.p.m. for the 12-in. size, and 800, 1150 and 1450 r.p.m. for the 16-in. size. A slight improvement in efficiency has been made in the machine this year, the 12-in. 115-volt motor taking 0.43 ampere instead of 0.45. The bearings are self-aligning and self-oiling, as heretofore, and the construction of the machine is of the familiar concentric field-coil type, which is characteristic of all of the smaller Lundell motors. Fig. 27 illustrates the bracket mounting of the Lundell machine.

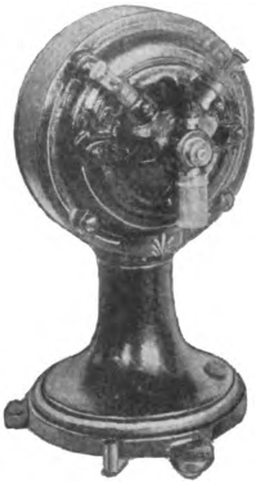


FIG. 28.—LUNDELL ALTERNATING-CURRENT DESK FAN MOTOR.

The alternating-current desk fan motor is of the same peculiar construction that was used last year. The field magnet has eight poles and the armature is provided with two windings, one consisting of eight coils close-circuited on themselves, and the other of an ordinary drum winding connected to the commutator. The field magnet is wound in the usual way and the winding is connected in series with the commutator brushes. The motor starts up as an ordinary series-wound machine, and as it approaches synchronism the short-circuited armature windings act in precisely the same way as the squirrel-cage armature of a single-phase induction motor, and give the armature an impetus which carries it up to synchronous speed. When running at this speed the current in the drum winding is rectified, so that the armature core is magnetized by a pulsating direct current, and its function is then identical with that of a revolving field magnet. The current in the field magnet proper remaining alternating, this part of the machine serves as a stationary armature, and the machine then runs as a synchronous motor with a revolving field magnet.

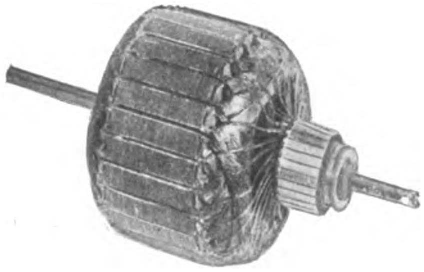


FIG. 29.—ARMATURE OF LUNDELL ALTERNATING-CURRENT DESK FAN MOTOR.

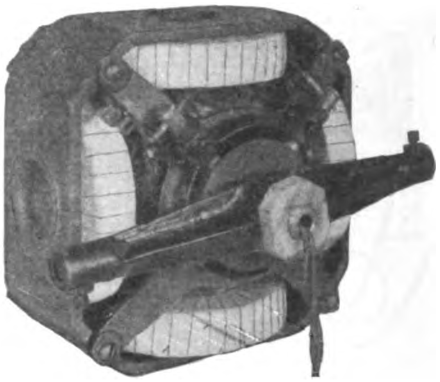


FIG. 30.—EMPIRE CEILING MOTOR.

Fig. 28 is a rear view of the machine showing the mounting of the brushes on the frame, and Fig. 29 illustrates the armature. While Fig. 28 illustrates the machine with a rigid mounting, it is also provided with the swivel and trunnion mounting, like that of the direct-current motor.

The motor of the Empire ceiling fan, built by the Sprague Company, is illustrated by Fig. 30, which shows it to be a four-pole machine of extremely compact construction. Only two brushes are used, the armature being provided with a two-circuit winding, and the field-magnet cores are hollowed in order to eliminate superfluous material and reduce the weight of the machine; this is shown more plainly in the cross-section of the machine, Fig. 32, which also shows the method of oiling the armature shaft. The armature shaft is hollow, and is almost completely submerged in a deep oil well, in which it revolves about a stationary spindle. The armature is a slot-wound drum, and runs at 135 r.p.m. The machine is built for 115, 165, 230 and 250 volts. The current consumptions at the

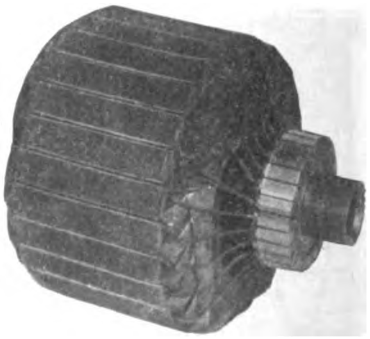


FIG. 31.—ARMATURE OF EMPIRE CEILING FAN MOTOR.

respective voltages named are 0.95, 0.64, 0.57 and 0.53 amperes. The sweep of the blade is 56 ins., and the fans are furnished with electroliers when desired.

The Western Electric Company's desk fan motor is of the same general type as that used last year, embodying a bipolar inverted horseshoe field magnet with the armature entirely enclosed by caps fitted to the pole-pieces on each side. Fig. 33 is an external view of the 12-in. fan, and Fig. 34 is a cross-sectional view of the machine. The internal construction is the same as that used last year, with the exception of the bearing brackets. These have been provided with enclosing shields at the inner ends of the bearings, which, in conjunction with a washer on the shaft at the fan end, and a flange on the commutator nut at that end, prevent the creeping of oil into the machine, and thereby allow a greater range in the quality of oil used. The bearings are of the wick-oiling type, with self-aligning bushings of babbitt. The speed-controling switch, *D*, has been slightly modified and improved. The rheostat, *C*, consists of a porcelain spool wound with German silver wire, which is embedded in, and coated over, with white enamel, baked at the highest temperature so as to make the rheostat practically indestructible. This machine is also made with the bracket form of mounting, in which case the motor is mounted on a universal ball joint, allowing the machine to be adjusted in any direction. The body of the machine is highly finished in black enamel, the fan blades, guards and oil-cup trimmings are finished in black enamel, or are polished in lacquered brass, or are nickel-plated, according to the desire of the user. These machines are wound for operation on standard direct-current circuits of 110, 220 and 500 volts.

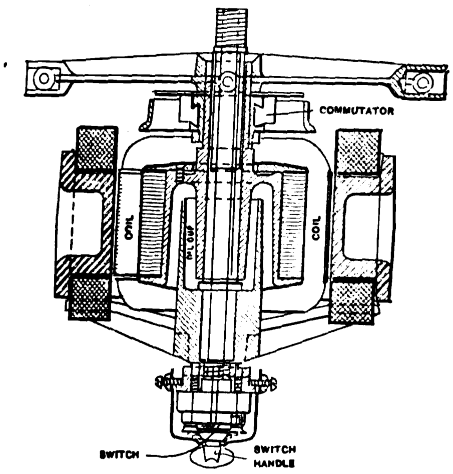


FIG. 32.—SECTION OF EMPIRE CEILING MOTOR.

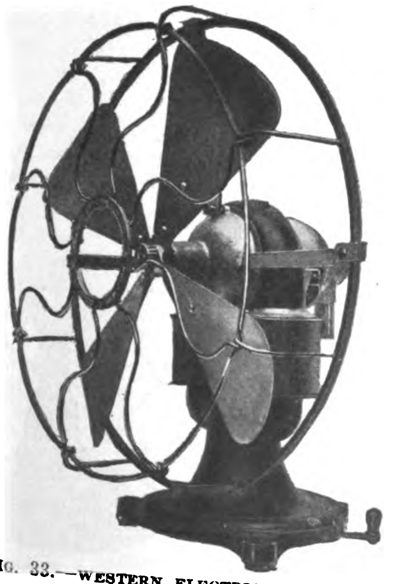


FIG. 33.—WESTERN ELECTRIC DESK FAN.

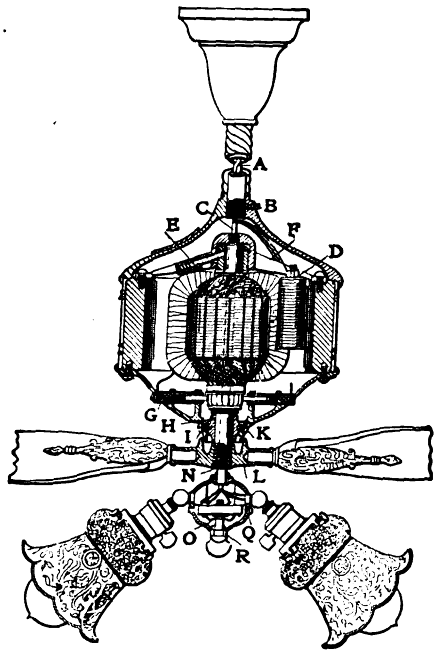


FIG. 35.—WESTERN ELECTRIC DIRECT-CURRENT CEILING FAN.

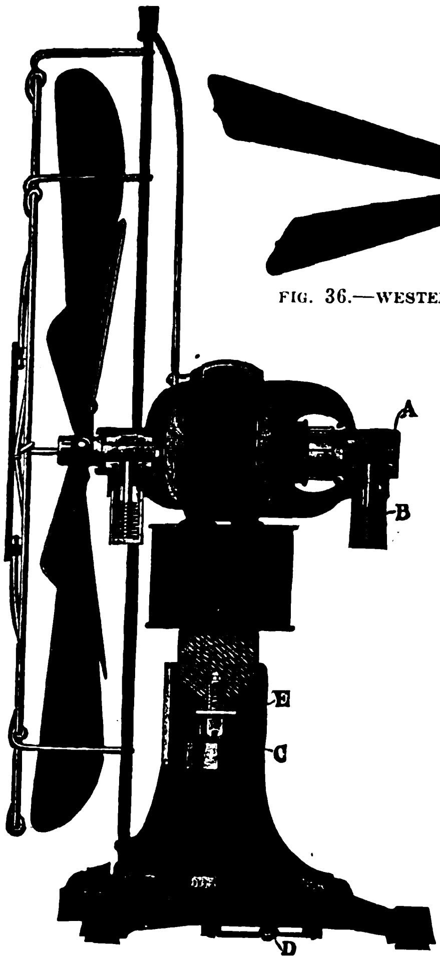


FIG. 34.—CROSS SECTION OF WESTERN ELECTRIC DESK FAN.

The Western Electric ceiling fans illustrated by Figs. 35 and 36 are equipped with bipolar motors having slotted drum-wound armatures of the usual type. The cross-sectional view in Fig. 35 shows plainly the construction of the machine. The commutator is located beneath the armature, and the brush-holders, *G*, are of the cartridge type, with pencil brushes. The upper bearing is oiled by means of a wick, *E*, from one side, and a cup is provided on the shaft to prevent the leakage of oil into the armature winding. The shaft is hollow, and a small hole in the side of it, immediately above the protecting cup, allows the oil to pass through the shaft from the upper bearing to the lower bearing, *H*, after lubricating which the oil is finally caught in a cup formed in the upper part of the fan-blade hub, *L*. A rather heavy oil is used for lubrication, in order to prevent its running through too rapidly. A notable feature of the structure is that the armature-shaft bearing is fastened directly to the magnet frame by braces, so that there is no opportunity for the armature to get out of alignment with the field magnet. This permits the air-gap to be made very small, conducing to high efficiency in the machine. It also renders the casing independent of the working parts of the motor, so that the machine can be set up and tested in operation with the casing removed.

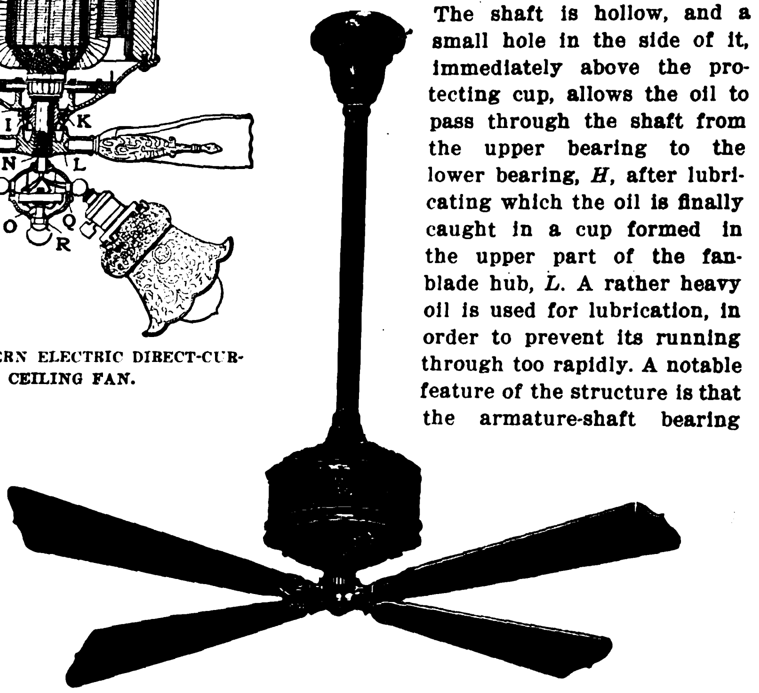


FIG. 36.—WESTERN ELECTRIC "POLAR" CEILING FAN.

Speed regulation is provided by means of a rheostat, *D*, sections of which are cut in and out by the switch, *R*, which is located at the extreme lower end of the fan. The perspective view, Fig. 36 shows the Western Electric Polar fan motor, which is of precisely the same construction as the standard fan in Fig. 35, with the exception of the regulating switch, there being no switch and rheostat provided with the Polar machine. These machines are wound for 110, 170, 220, 250 and 500 volts. The W. E. standard 110, 220 and 500-volt motors are provided with regulating switches, but neither the polar nor the standard 170-volt and 250-volt machines are provided with switches, these motors being intended to run in groups of three and two in series on 500-volt circuits, and to be controlled by a wall switch and rheostat. The standard sweep of all of the machines is 58½ ins.

Fig. 37 illustrates a bracket fan having a field magnet similar in type to the Western Electric desk and bracket fan. This machine is made by D. L. Bates & Bro., Dayton, Ohio, and is built also with the pedestal form of mounting for desk service. The magnet cores are of forged steel, and the armature is of the usual slotted-drum type. These machines are built for 110, 220 and 500-volt circuits. The bracket motor is provided with universal socket adjustment and the desk motors are equipped with a swivel and trunnion mounting, as illustrated in Fig. 38. The current consumption of the various machines is as follows: 12-in. fan at 110 volts, 31 watts; at 220 volts, 44 watts; 16-in. fan at 110 volts, 60 watts; 220 volts, 83 watts, and at 500 volts, 125 watts. All of the fans are provided with three-speed switches, giving speeds of 1500, 1700 and 1900 r.p.m. in the 12-in. size; 1200, 1350 and 1900 r.p.m. in the 16-in. 110-volt machine; 1400, 1500 and 1600 in the 16-in. 220-volt machine, and 1300, 1400 and 1500 in the 16-in. 500-volt machine.

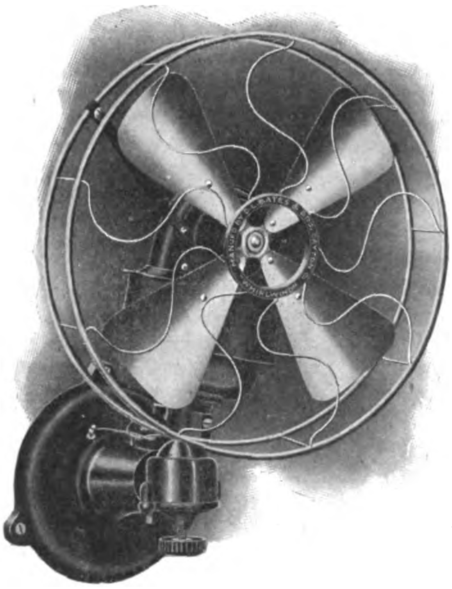


FIG. 37.—BATES DIRECT-CURRENT FAN.

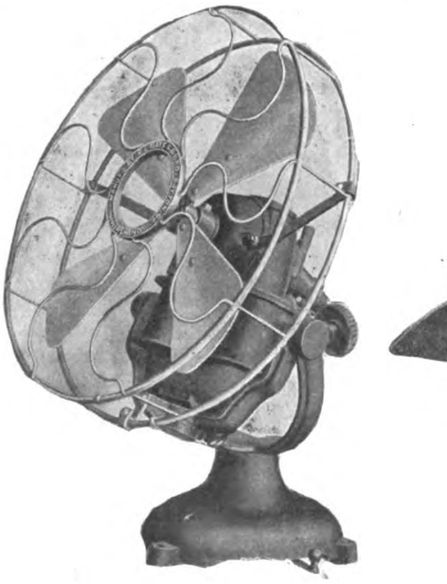


FIG. 38.—BATES TRUNNION FAN.

Fig. 39 illustrates the Bates four-blade ceiling fan, which is built for 110, 167, 220, 250 and 500-volt circuits. The motor is a six-pole machine with a drum-wound armature, the wire being wound in round holes in the armature core. The engraving shows a fan with an electrolier attachment, but it is, of course, also supplied without this. Fig. 40 shows the armature of this machine. This fan is known as Style A, and is not provided with any speed regulation. A ceiling fan of the same construction, so far as the motor is concerned, is built with a three-speed switch and rheostat, this type being known as the Imperial fan. It is built only for 110, 220 and 500 volts.

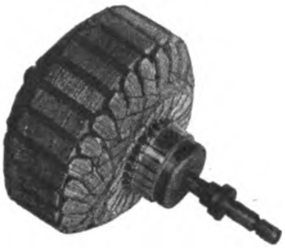


FIG. 40.—BATES CEILING FAN MOTOR ARMATURE.

The Emerson Electric Manufacturing Company's alternating-current fan motors for 1902 are of extremely symmetrical and compact form. Fig. 42 illustrates the two-speed desk fan for low-frequency current, provided with swivel and trunnion mounting. The running speeds are 1300 r.p.m. and 1650 r.p.m., and the current consumption is 45 watts at the slow speed and 55 watts at full speed for the 12-in. size; 80 watts at slow speed, and 90 watts at full speed for the 16-in. size. These machines are wound for all of the standard alternating-current secondary voltages. This type of machine is also built in bracket form, as illustrated in Fig. 41, the only difference being the form of mounting. Fig. 43 illustrates the field magnet and armature of the machine, and shows that the field is provided with "starting" coils, located midway between the working coils, so as to give the necessary auxiliary field 90° from the working magnetic field for starting. The armature or rotor is of the usual squirrel-cage type, as shown in this engraving.

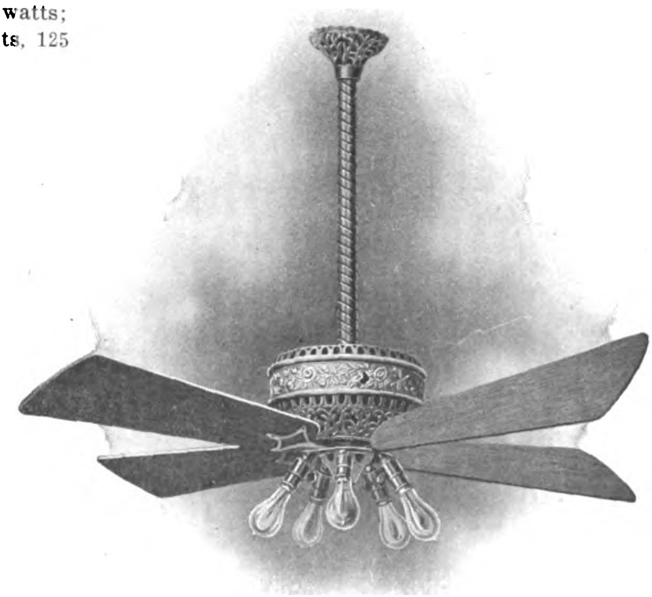


FIG. 39.—BATES DIRECT-CURRENT CEILING FAN.

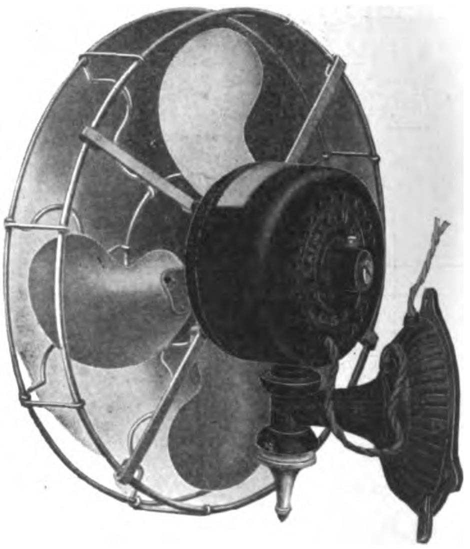


FIG. 41.—EMERSON BRACKET FAN MOTOR.

Fig. 44 illustrates the method of lubricating the armature bearings. There is no armature shaft, the armature core being mounted on a bronze drum provided with extensions, *F* and *F*, at each end, which fit around a stationary hollow spindle, *M*, and constitute bearings. The fan is provided with a hollow hub, *J*, screwed on the projection at one end of the armature core-drum, so as to completely enclose the bearing at that end. The outer end of the bearing at the other end of the armature is enclosed by a rawhide washer, *E*, mounted on a portion of the frame, *B*. Lubrication is provided through the oil cup, *A*, the lubricating

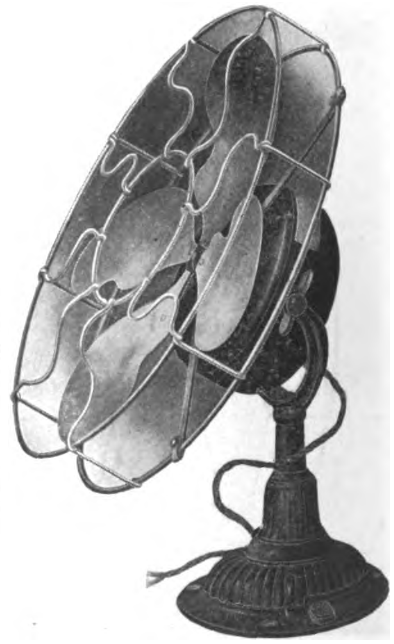


FIG. 42.—EMERSON DESK FAN MOTOR.

oil being delivered to the interior of the hollow spindle, *M*, and finding its way through holes, *L* and *L*, to the bearings, *F* and *F*; the hollow fan hub, *J*, catches the oil at that end of the armature, and it is prevented from leaking out at the other end by the rawhide washer mentioned above. A cavity, *N*, within the armature spider, is provided for the retention of a reserve lubricant.

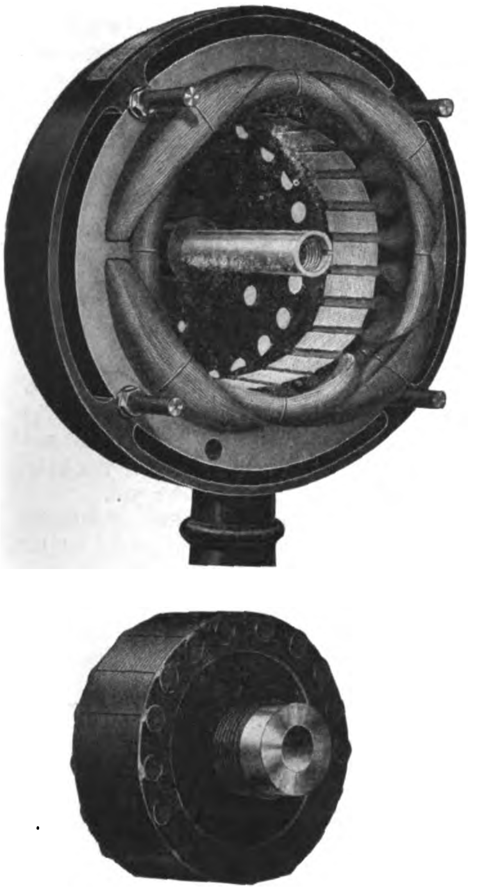


FIG. 43.—EMERSON FIELD MAGNET AND ROTOR.

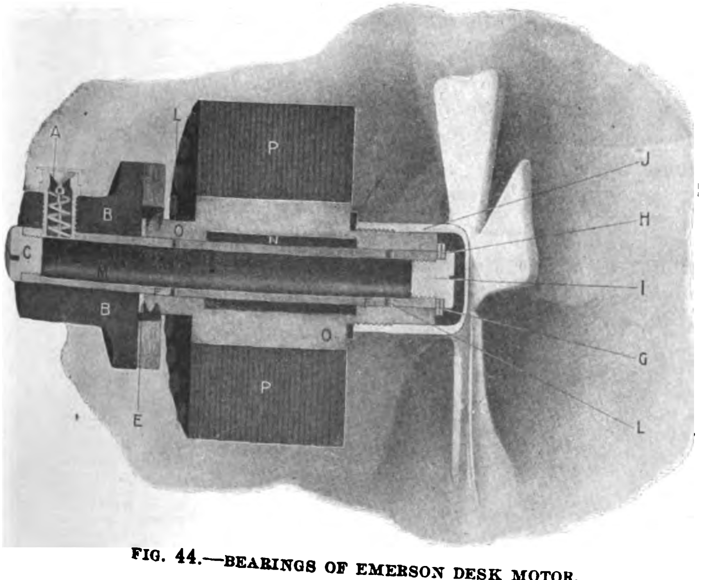
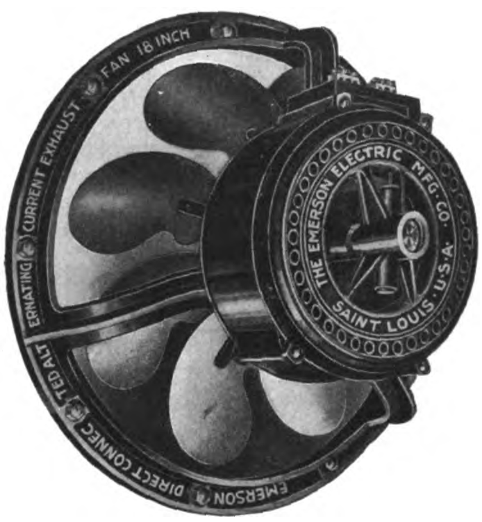


FIG. 44.—BEARINGS OF EMERSON DESK MOTOR.

Fig. 45 represents a compact ventilating outfit made by the Emerson Company, in which the standard self-starting, single-phase motor is used, with a special exhaust fan mounted in a circular framework, as shown. This outfit is built in two sizes, 12 ins. and 18 ins., the smaller machine requiring 125 watts at full speed and the larger one 375 watts at full speed.

Fig. 46 represents a new outfit which has just been put on the market this year by the Emerson Company. This is a direct-current ventilating equipment, and, like the alternating-current equipment, is built in two sizes, 12 ins. and 18 ins.; the 12-in. outfit requires 110 watts at full speed and the 18-in. equipment 275 watts.


FAN 18 INCH
THE EMERSON ELECTRIC MFG. CO.
SAINT LOUIS U.S.A.
EMERSON DIRECT CONNECTED ALTERNATING CURRENT EXHAUST

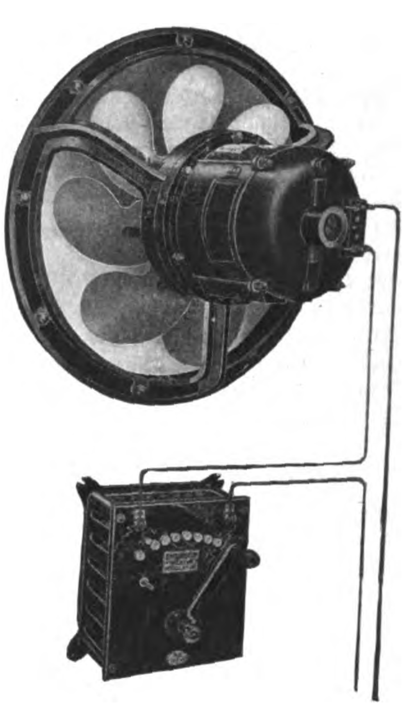


FIG. 45.—ALTERNATING AND DIRECT-CURRENT VENTILATING OUTFITS.—FIG. 46.

The Emerson ceiling fan this year has been modified from last year's design. The machine is a single-phase induction motor, with a squirrel-cage rotor, the conductors of which are flat copper strips instead of round rods. This machine is built for two speeds, being provided with a speed-regulating coil, *G*, Fig. 47, and a regulating switch, *P*. The motor has 28 field-magnet poles, only 14 of which are wound. These 14 poles are provided with slots in the center for the reception of starting coils, which are wound on one-half of each pole, and are put in service only when the machine is first switched into circuit. The peculiar oiling system used last year has been retained. This consists of a spiral groove within the hollow armature shaft, which raises oil to the top of the shaft, whence it trickles down again and lubricates the bearing. Fig. 48 is an exterior view of the complete fan, which is made in several sizes, the standard sweeps being 50 and 56 inches.

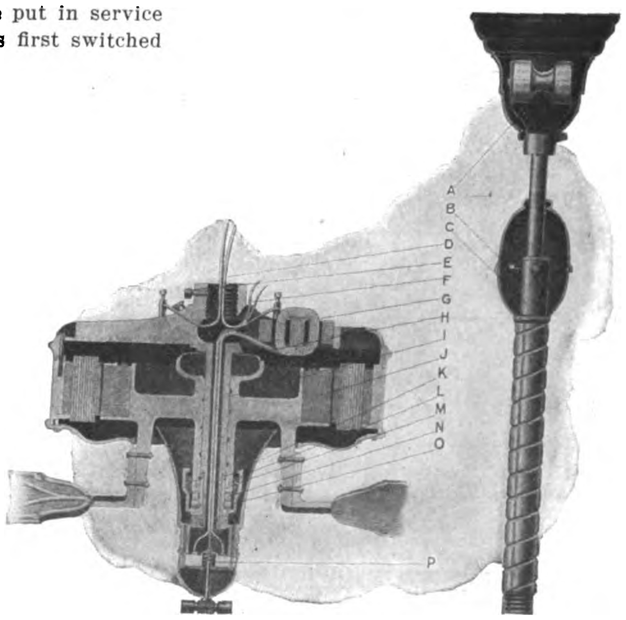


FIG. 47.—SECTION OF EMERSON CEILING FAN MOTOR.

Fig. 49 illustrates the desk fan of the Holtzer-Cabot Electric Company, Boston, Mass., which has not been appreciably changed from last year's design. The whole of the field magnet is cast in a single piece of soft steel and is spherical in its external contour, with the exception of the flattened surfaces at opposite ends of the armature axis, to which flat end caps are bolted. The illustration shows the construction very plainly. The magnet is bipolar and the field-magnet coils are inserted through one of the openings in the field casting. They are held in place by a brass ring, which presses against both the upper and lower coils and prevents their accidental displacement. The armature is of the usual construction, having a slotted core and drum winding. The end caps are simple discs of iron in which are cast the grease cups, so that no separate parts are required and there are consequently no joints to render leakage possible. The journal caps can be rotated into any one of four positions so as to bring the grease cup above the bearing, no matter whether the motor be used on a desk, screwed to a wall, or mounted on a ceiling. The bearing bushings are of phosphor bronze, self-aligning.

The brush-holders are unusually efficient without being at all complicated. Fig. 51 shows a brush and brush-holder full size and the construction will be obvious at a glance. The tension of the spring gives practically uniform pressure throughout the life of the brush; the slot through which the tension finger moves is closed at the front end of the brush-holder so that the finger cannot come in contact with the commutator in case the machine should be used without attention until the brush is worn down sufficiently to drop out. The brush-holder may be readily removed from the case by merely loosening the nut and turning the button (which holds the brush-holder to the end of the insulating plug) at right angles to its normal position. A four-speed rheostat is mounted in the base and the connecting cord is fastened to terminals on the inside of the base, so that there is no danger of their becoming short-circuited or of the user receiving a shock. Fig. 50 shows a Holtzer-Cabot fan with a special mounting for suspension from the ceiling. This machine is provided with a worm adjustment for tilting it to any desired angle.

A machine having a field magnet of almost precisely the same design as the Holtzer-Cabot is the Hurricane desk motor, built by the Eck Dynamo & Motor Works, Belleville, N. J. Fig. 52 gives a cross-sectional view through one of these machines provided with a rigid mounting, from which it will be clear that the armature and field coils are inserted through openings on opposite sides of the spherical casting, and the bearings are contained in the end caps, which close these openings, as in the case of the Holtzer-Cabot machine. This machine was fully described last year, and as no changes have been made in its construction, a further description now is unnecessary. It should be noted, however, that it is built also with an adjustable ball-and-socket joint between the body of the motor and the pedestal, by means of which the machine can be set at any desired angle. As shown in the engraving, this motor is provided with a speed regulating switch and rheostat, the latter being enclosed in the pedestal. The motor is built for 115-volt and 230-volt circuits, and with 12-in. and 16-in. blades. The speeds of the 12-in. fan are 900, 1400 and 1800 r.p.m., and the speeds of the 16-in. fan are 800, 1200 and 1600 r.p.m.

Still another spherical form of machine is the Colonial desk fan, built by the Colonial Electric Company, Ravenna, Ohio, and illustrated by Figs. 53 and 54. Fig. 53 shows the swivel and trunnion desk machine with a 12-in. fan, which is known as Type S-1, and Fig. 54 shows the bracket mounting of the same machine in the 16-in. size, which is known as Type S-4. Both machines are provided with the usual form of speed-regulating switch and rheostat mounted in the base. The normal running speed of the 12-in. fan is 1650 r.p.m., and the power consumption is 55 watts. The 16-in. fans run at 1350 r.p.m., and the power consumption is 77 watts. The bearings are of phosphor bronze, self-aligning, and provided with wick-feed lubrication. These fans are also built with rigid mounting, in which

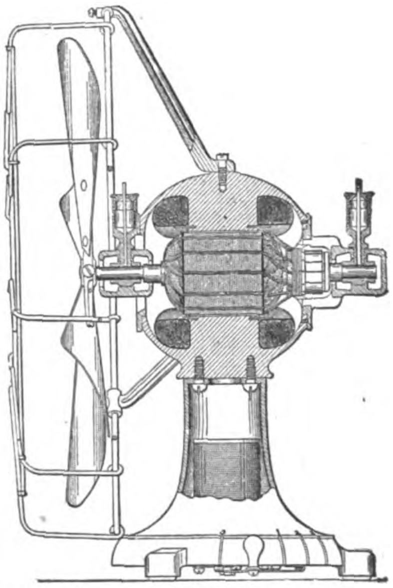


FIG. 52.—SECTIONAL VIEW OF HURRICANE DESK FAN MOTOR.

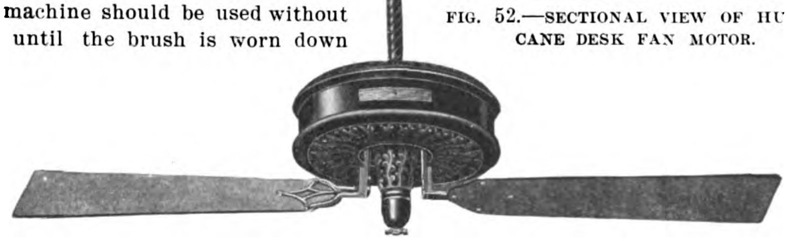


FIG. 48.—EMERSON CEILING FAN.

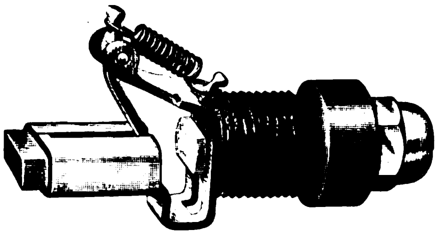


FIG. 51.—HOLZER-CABOT BRUSH HOLDER.

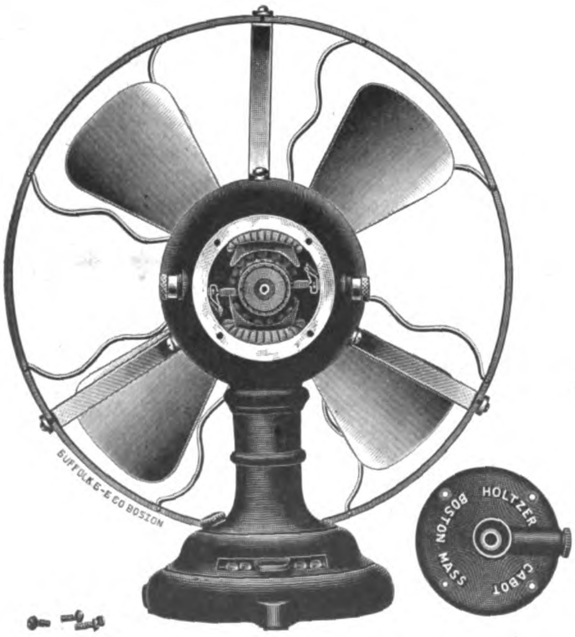


FIG. 49.—HOLZER-CABOT DESK FAN.

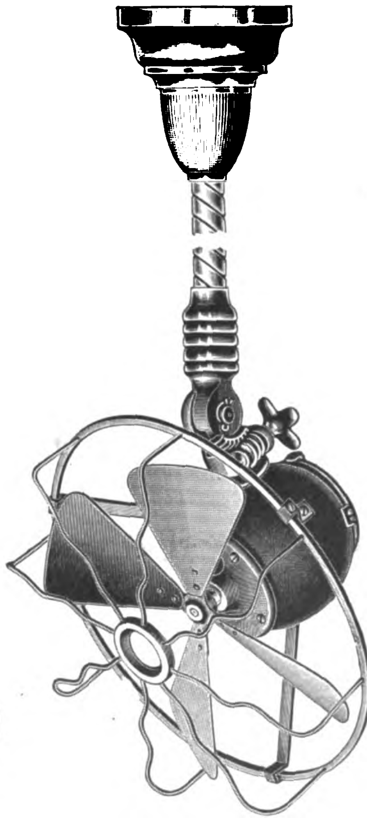


FIG. 50.—HOLZER-CABOT CEILING SUSPENSION FAN.

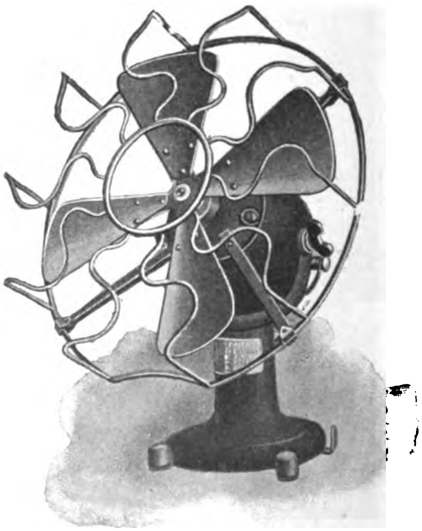


FIG. 53.—COLONIAL DESK FAN.

form they are known as Type T-1, Type T-2, etc. They are sold in the East by J. Jones & Son, New York.

The Colonial ceiling fan is illustrated by Fig. 55, which shows the Type R machine. The brush-holders and brushes are of the cartridge and carbon-pencil type. The bearings are of phosphor bronze, self-oiling and self-aligning, and of such construction that the working parts are constantly immersed in oil. The sweep is 60 ins., and the speeds are 110 and 220 r.p.m. with four blades, or 130 and 220 r.p.m. with two blades; a two-blade switch being provided with each fan. These machines are wound for 110, 170, 220, 250 and 500 volts, and the current consumption at each of these voltages is 1 ampere, 0.7 ampere, 0.55 ampere, 0.45 ampere and 0.23 ampere, respectively.

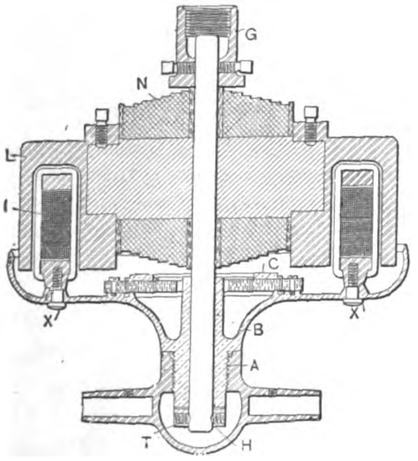


FIG. 57.—CROSS SECTION OF DAYTON CEILING FAN MOTOR.

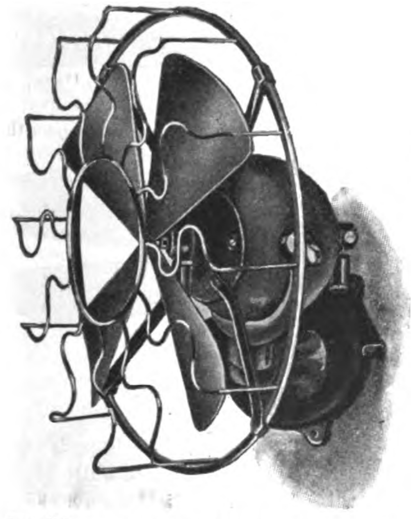


FIG. 54.—COLONIAL BRACKET FAN MOTOR.

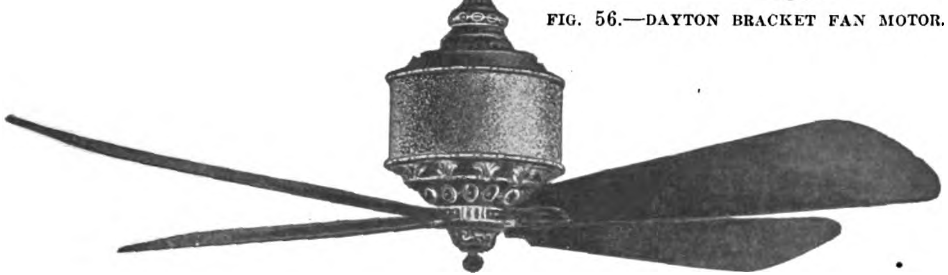


FIG. 55.—COLONIAL CEILING FAN MOTOR.

Fig. 56 illustrates a graceful design of bracket motor built by the Dayton Fan & Motor Company, Dayton, Ohio. This machine is bipolar and equipped with the usual form of slot-wound drum armature, cartridge and pencil brush-holders and brushes, under-feed self-oiling bearings, and three-speed regulation. The machine is built in three styles of mounting; the swivel and trunnion bracket mounting, shown in the engraving, the same style of mounting in pedestal form for desk service, and a rigid pedestal mounting. The motor is wound for 110, 220 and 500 volts. The speeds are 1800, 1300 and 800 r.p.m., and the power consumption for the 12-in. fan is 44 watts. The construction is very similar to that of the Dayton Junior ceiling fan motor, described farther along in this article.

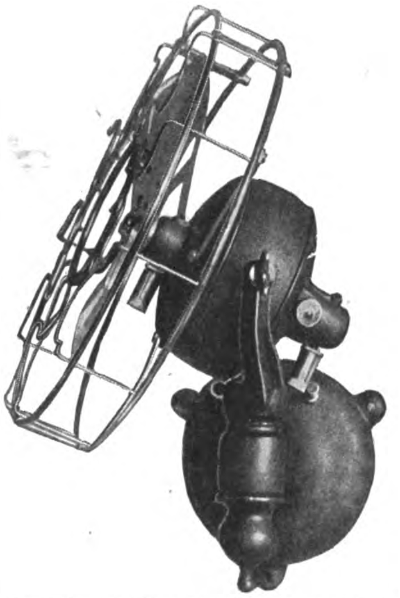


FIG. 56.—DAYTON BRACKET FAN MOTOR.

Fig. 58 illustrates the Dayton Fan & Motor Company's standard ceiling fan for 500 volts, and Fig. 57 is a cross-section through the motor of this machine. It will be evident from an inspection of the latter engraving that the field magnet is bipolar and has channeled pole-pieces which embrace three sides of the armature cross-section. The armature winding is necessarily of the Gramme ring type, and the arrangement of the air-gap obviously results in a very low magnetic reluctance in this part of the circuit. The field-magnet coil, *N*, is divided into two sections, in order to leave the center of the core free for the passage of the armature spindle. The armature is secured by means of the screws *X* and *X* directly to the ornamental casing, *B*, which closes the motor in on the under side, and this casing also carries the commutator, *C*, which is of the disc type. The casing, *A*, with which the fan-blade sockets are integral, is screwed onto a hub at the bottom of the casing, and contains a large cup, *T*, for the retention of the oil that trickles through the bearing. Oil is supplied to this bearing from the reservoir located immediately beneath the commutator. There is, properly speaking, no armature shaft, the casing, *B*, revolving about the stationary spindle, *H*, which is held in the socket, *G*, by means of set screws. The Dayton standard fan is supplied ordinarily with four blades for all circuits except 500 volts, and runs at 215 r.p.m. The 500-volt fan is provided with two blades, as shown in Fig. 58, and runs at 210 r.p.m.

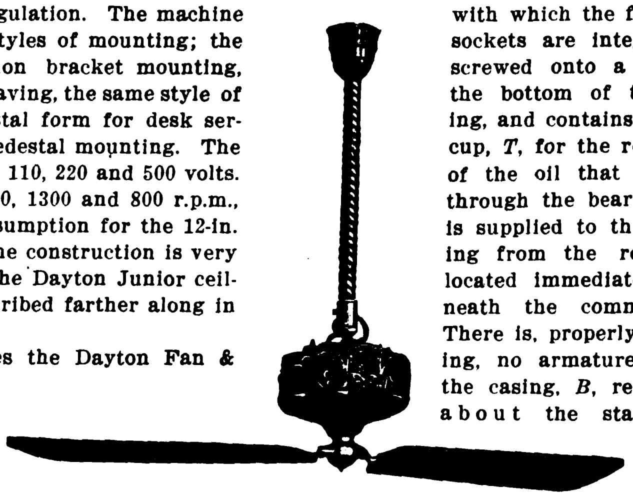


FIG. 58.—DAYTON CEILING FAN MOTOR.

Fig. 59 illustrates the Dayton Junior ceiling fan motor, in which engraving the principal features of the construction are obvious. In this machine the usual form of armature shaft is employed. The case is stationary, being mounted solidly on the field-magnet frame, *A*. The lower bearing is lubricated from the reservoir in that part of the casing marked *B*, the

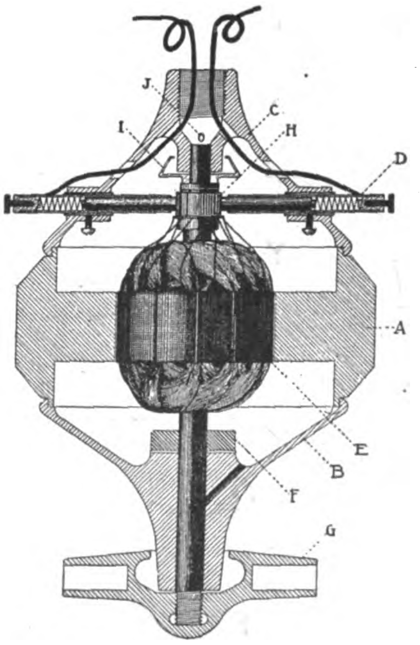


FIG. 59.—DAYTON "JUNIOR" CEILING FAN MOTOR.

oil being caught in the cup formed in the upper part of the fan-blade hub; the upper bearing is oiled from the reservoir, *J*, the oil that trickles through being caught in the cup, *I*, mounted on the armature shaft. The commutator of this machine is of the usual type, and the brush-holders of the cartridge type, provided with adjusting screws. The Dayton Junior fan is usually provided with four blades, and runs at 225 r.p.m.

Fig. 62 illustrates the Peerless Type H-2 ceiling fan, which is built for all of the usual direct-current voltages, and Fig. 61 is a cross-section of this machine. The motor is bipolar, with form-wound coils throughout, and the machine is similar in general design to the Robbins & Myers motor, shown by Fig. 23. The lubrication of the bearings is effected in precisely the same way, and the switch spindle passes up through a hollow armature shaft, as in the case mentioned. The bearings are of high-grade gun metal and the bushings are self-aligning. The brushes and brush-holders are of the carbon pencil and cartridge type, which is now so universally used, and are accessible without removing any of the casing. The sweep of the blades is 60 ins., and the normal speed with four blades is 200 r.p.m.; with two blades the speed is increased to 220 r.p.m. The power consumption ranges from 110 to 115 watts, according to the voltage. The 500-volt fans run at one speed only, but those for lower voltages are provided with a two-speed rheostat in conjunction with the switch.

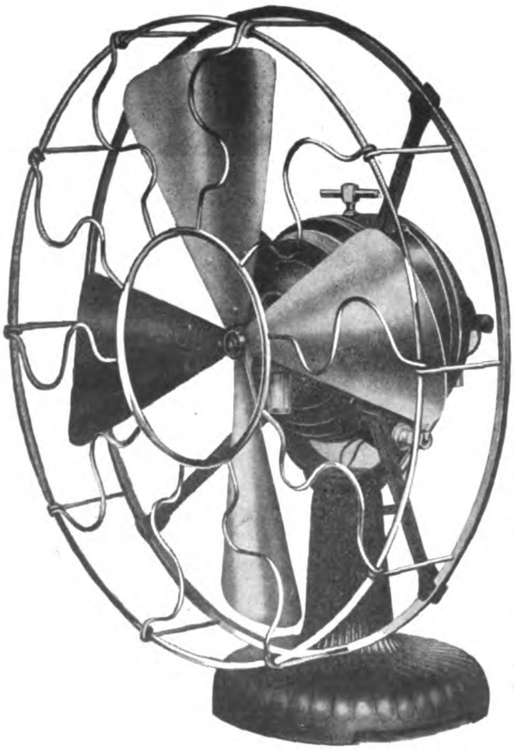


FIG. 60.—PEERLESS DESK FAN MOTOR.

The Peerless desk fan motor, manufactured by the Warren Electric & Specialty Company. Warren. Ohio, is illustrated by Fig. 60. This machine is of the usual enclosed form, provided with self-oiling bearings and automatic-feed brush-holders. The construction of the brush-holders is such that the brushes can be removed and replaced in a few moments without the use of tools. The machine is provided with swivel and trunnion adjustment, and also with the usual rheostat and switch in the base.

A somewhat similar form of machine is built by the George C. Towle Manufacturing Company, Lancaster, Pa., illustrated by Fig. 64. The field magnet of this machine is bipolar and of the construction shown by Fig. 63, from which it will be evident that the field-magnet coils can be inserted and removed without necessitating the use of a removable pole-shoe. The triangular holes cored through the magnet pole immediately opposite the centers of the pole faces are for the purpose of taking out superfluous material. The machine is provided with self-oiling and self-aligning bearings, which are lubricated by means of the usual under-feed wick, and is equipped with a rheostat and switch which enable it to operate at 1000, 1600 and 2000 r.p.m. The motors are built for all of the usual direct-current voltages, and in both pedestal and bracket forms.

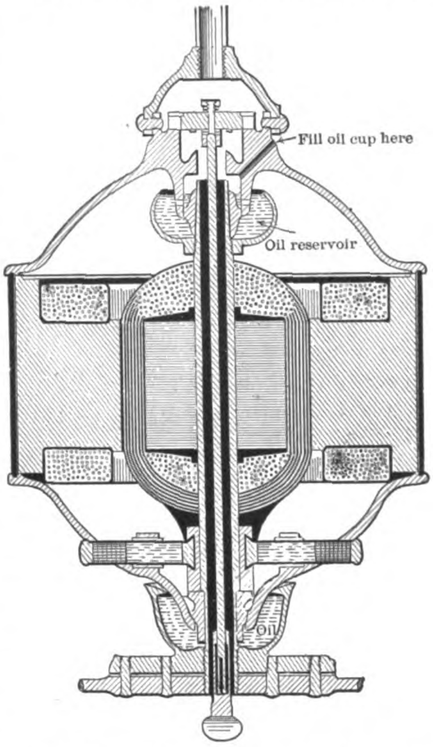


FIG. 61.—SECTION OF "PEERLESS" CEILING FAN MOTOR.

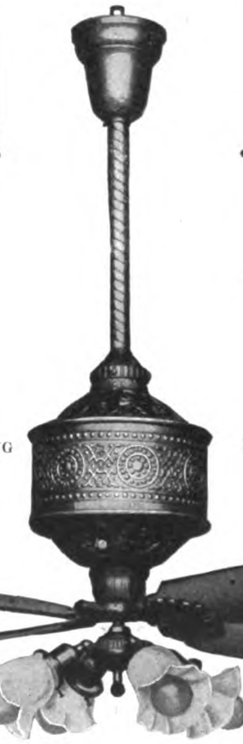


FIG. 62.—PEERLESS CEILING FAN MOTOR.

Fig. 66, herewith, represents the Towle column fan, the motor of which is a multipolar machine with a drum-wound armature of usual construction. This fan is built for the ordinary voltages, and also for use on 550-volt circuits direct. The field-magnet coils are form-wound, heavily varnished and baked before being taped. The fan is provided with either two blades, as shown in the illustration, or with four.

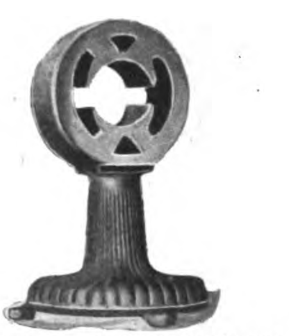


FIG. 63.—FIELD MAGNET "ECLIPSE" DESK FAN MOTOR.

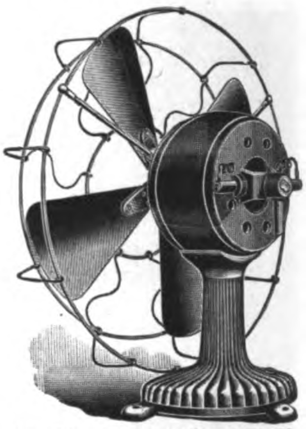


FIG. 64.—"ECLIPSE" DESK FAN MOTOR.

Fig. 69 illustrates an extremely graceful design of ceiling fan which is new this year. This machine is built by the Sterling Electric Motor Company, of Dayton, Ohio, and every part is made to gauge by automatic machinery, so that repair parts are strictly interchangeable with the originals, and the cost of manufacture is reduced without sacrificing the machine. The motor is wound for the usual direct-current voltages, and its de-

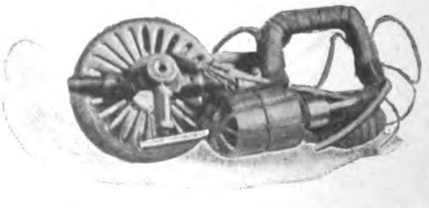


FIG. 65.—PARTS OF "ECLIPSE" DESK FAN MOTOR.

sign is of a conventional type; but special care has been given to the construction of the machine, with a view to making it durable and thoroughly reliable in operation. The speed-regulating rheostat is of fireproof construction, and is located above the motor, so that it has full ventilation, and the heat generated in it cannot affect the bearings or windings of the machine. The regulating switch is also located at the top of the motor and operated by means of a spindle extending through the hollow armature shaft, as in the cases previously cited, and terminating in a key below the fan-blade hub. the brush-holders are of the usual cartridge type, with radially-fed brushes which can be removed and replaced without disturbing any other part of the machine. The bearings are immersed in large oil baths, insuring continuous and thorough lubrication throughout the season.

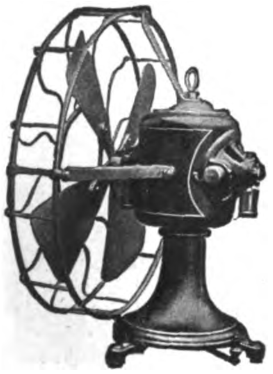


FIG. 67.—PARAGON DESK FAN MOTOR.

Fig. 67 illustrates the Paragon desk fan motor, which has been well known for several years past. The principal improvements in the 1902 model consist of an improved guard support and improved adjustment for the swivel and trunnion types. The new guard support consists of four radial arms of substantial brass strap, attached to the fan guard at equidistant intervals and bolted at their other ends to the motor frame, as clearly shown in Fig. 68, which illustrates the bracket mounting of the swivel and trunnion form of machine. The fan-guard support for the stationary pedestal type has also been improved, in that the fan guard is secured to the motor frame at four equidistant points, as in the case of the trunnion form of machine, being screwed directly to the base at one point and held by three radial arms at the other three points, as illustrated in Fig. 67. This form of adjustment is said to be so rigid that it is practicable to lift or carry the fan by the guard itself without straining the connections in the least.

An improvement has also been made in the method of securing the motor body in the various positions to which it is tilted between the trunnion arms. This consists of locating the clamping screw in the trunnion arm below the pivot, instead of using a clamping nut on the pivot stud itself. By means of this arrangement much less friction is required between the point of the screw and the motor frame to hold the machine securely than would be required with the older form of frictional clamping. In general design the motor has not been appreciably changed. The field magnet is a single casting of the inverted-barrel type, with openings diametrically opposite each other, through which the armature and field coils are inserted, and which are closed by caps carrying the bearings. The brushes are of the pencil type, mounted in cartridge holders, but rectangular in cross-section, so that they cannot turn in the holders and alter the area of contact on the commutator. The brush-holders are mounted in insulated bushing, in the rear end-cap, as shown in Fig. 67, and are readily removable. The bearings are self-aligning, of the self-lubricating under-feed wick type.

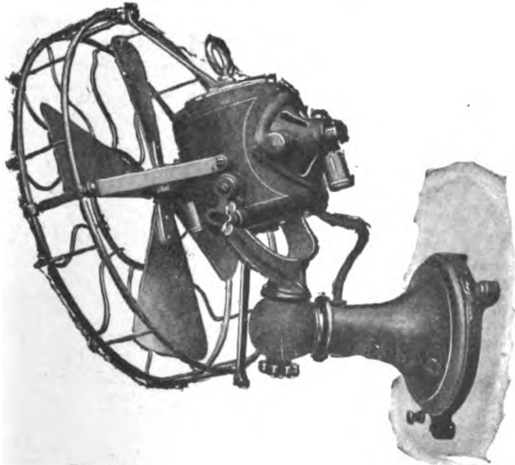


FIG. 68.—PARAGON BRACKET FAN MOTOR.

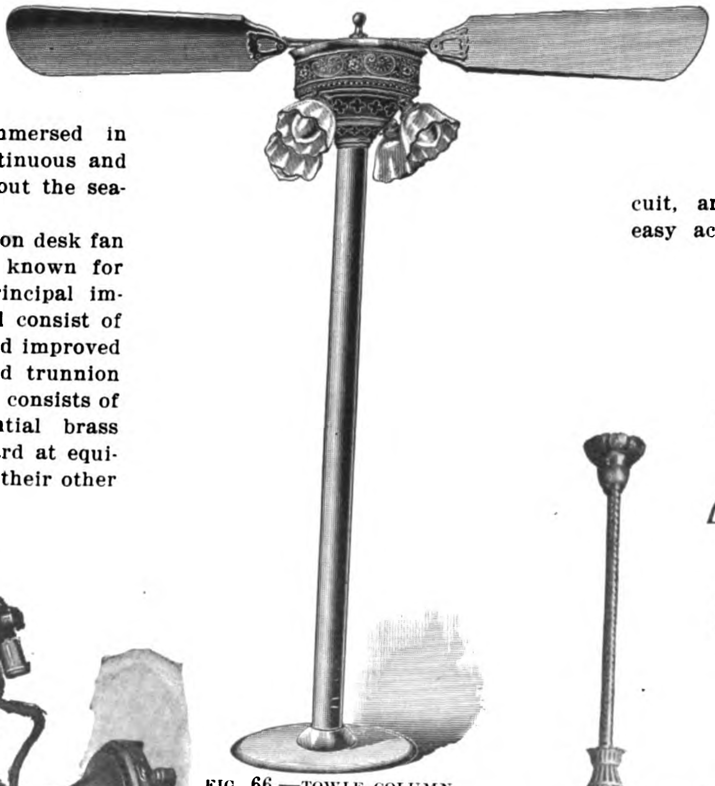


FIG. 66.—TOWLE COLUMN FAN.

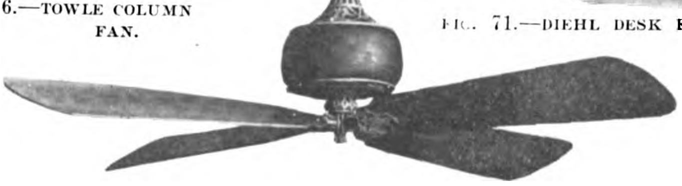


FIG. 69.—STERLING CEILING FAN MOTOR.

The desk fan of the Diehl Manufacturing Company, Elizabethport, N. J., is of the same exterior contour as the Paragon machine just mentioned, but the constructional features are somewhat different. The barrel forming the yoke-ring of the field magnet is split vertically in such a plane that the joint does not pass through the core of the field magnet, but only separates the yoke into two parts. This arrangement obviously gives a jointless magnetic circuit, and at the same time provides easy access to the interior of the machine. Fig. 71 illustrates the rigid pedestal mounting, and Fig. 70 shows the universal adjustment applied to the bracket mounting. As indicated in the engravings, the machines are provided

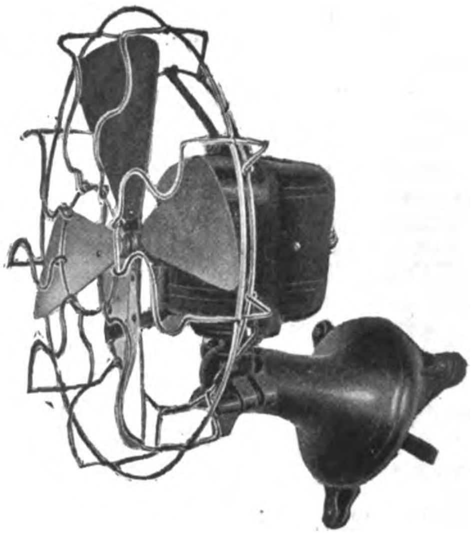


FIG. 70.—DIEHL BRACKET FAN MOTOR.

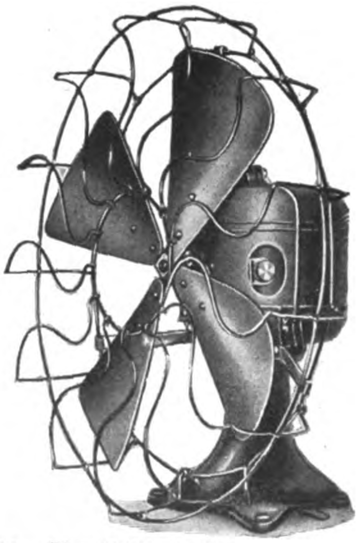


FIG. 71.—DIEHL DESK FAN MOTOR.

with the usual rheostat and speed-regulating switch mounted in the pedestal. The other details of construction are in conformity with standard modern practice, self-oiling and self-aligning bearings and self-feeding brushes being employed.

Fig. 73 represents the standard ceiling fan of the Diehl Manufacturing Company, the motor of which is a bipolar machine with a laminated internal field magnet, the armature being of the Gramme-ring external type. As the engraving clearly shows, a part of the case is attached directly to the armature and revolves with it, and the blades are mounted in sockets on this part of the casing. The fan here illustrated is known as the No. 17. Fig. 72 illustrates the Diehl No. 27 fan, the motor of which is of the ordinary internal armature type, with the shaft projecting below the casing to afford support for the fan-blade hub. These machines are wound for the usual direct-current voltages, and are supplied in a variety of ornamental casings. Three-speed regulating switches are supplied with the standard fans when so ordered, and ordinary switches for starting and stopping are provided on all of the fans when desired.

The Edison battery motor outfits are so well known that remarks concerning these excellent little machines are almost superfluous. Fig. 74 represents a 7-in. iron-clad motor with three cells of Edison-Lalande battery. This little machine drives a 7-in. four-blade fan at full speed for 150 hours with a single charge of the battery. The motor is of the usual bipolar type, with copper-leaf brushes. The battery is too well known to require description.

The Knapp battery fan motor, illustrated by Fig. 75, is a bipolar machine having a solid armature with six projections or teeth, which is wound with a modification of the Siemens winding. The machine shown in the engraving is the Type C motor, and drives an 8-in. four-blade fan at 1800 r.p.m. when supplied with current from three cells of an ordinary electropoion battery.

The little machine illustrated by Figs. 76 and 77, while not coming legitimately in the category of electric fans, will be, nevertheless, of interest to those of our readers who are interested in mechanically-driven fans. In this machine the fan is driven by a little water motor mounted on a ball-and-socket support, and provided with a flexible hose connection to permit of adjustment in any direction. The waste is carried away by the pipe shown leaving the center of the base. The machine is built in two sizes by the A. Rosenberg Company, Baltimore, Md., namely, 7-in. and 9-in. diameter of motor. With 15 lbs. of water pressure, the motor drives a six-blade 12-in. fan at 700 r.p.m.; with 20 lbs. the speed is 950 r.p.m.; with 25 lbs. it is 1050 r.p.m.; with 30 lbs. it is 1260 r.p.m., and so on, upward. It is obvious that the speed of the machine can be regulated within the maximum range afforded by the water pressure by merely adjusting the valve in the supply pipe. The manufacturers state that the cost of operation in the city of Baltimore is only $5 a year for each fan.

Fig. 78 illustrates the well-known Sturtevant bipolar motor which is used for driving ventilating fans, and Figs. 79 and 80 are transverse and longitudinal sectional views of the machine. The construction is entirely apparent from the engravings. The magnet cores are of wrought iron, bolted to the circular yoke-ring, and the pole shoes are of cast iron, screwed to the ends of the magnet cores. The end caps of the machine, as shown by Fig. 78, do not entirely enclose it, and

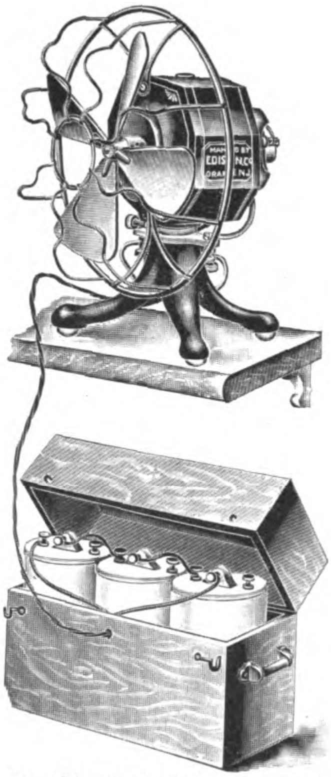

MADE BY EDISON ORANGE N.J.

FIG. 74.—EDISON BATTERY FAN MOTOR OUTFIT.

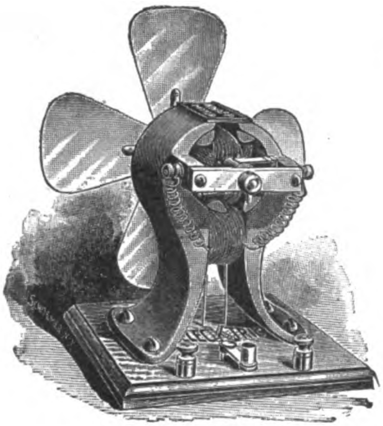


FIG. 75.—KNAPP BATTERY FAN MOTOR.

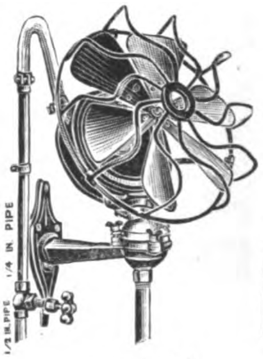


FIG. 76.

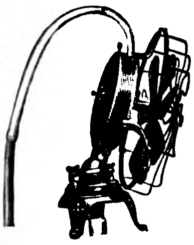


FIG. 77.

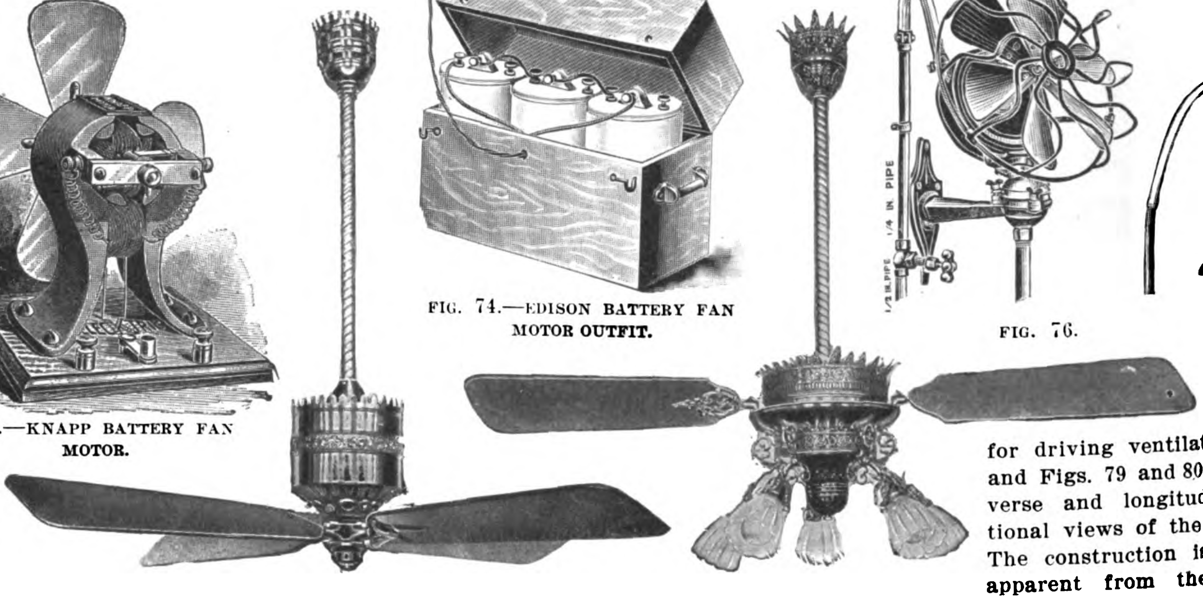


FIG. 72.—DIEHL CEILING FAN MOTORS.—FIG. 73.

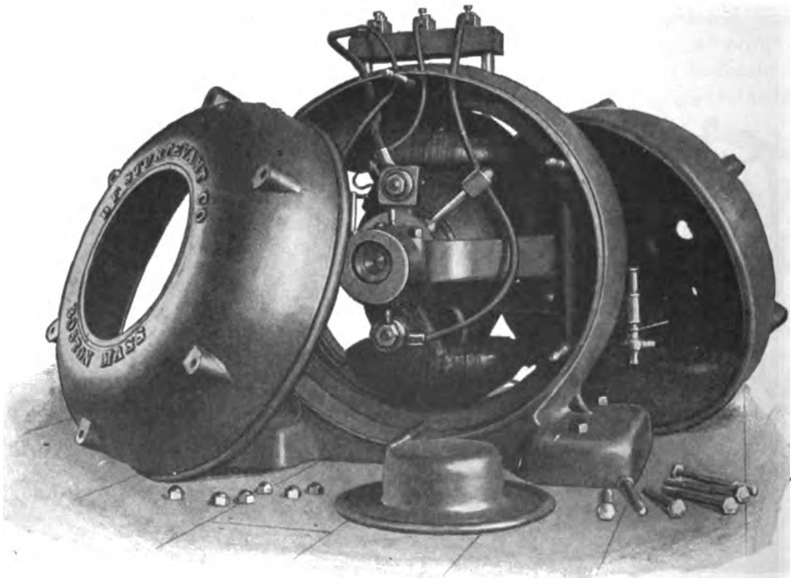


FIG. 78.—STURTEVANT BIPOLAR VENTILATING FAN MOTOR.

supplementary hat-shaped caps are employed to close the circular holes in the centers of the end caps.

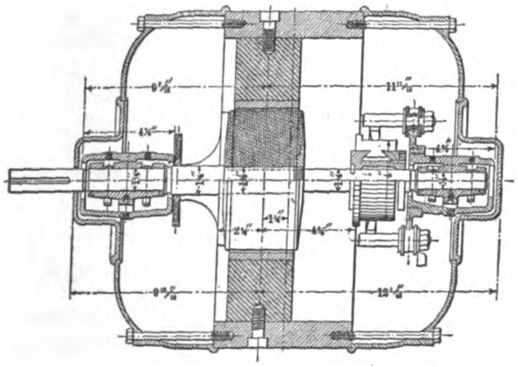
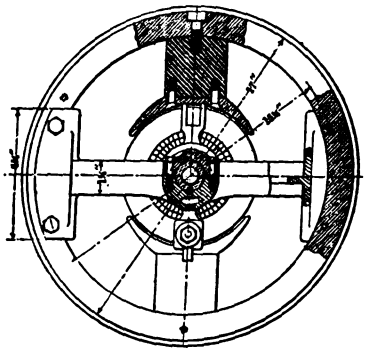
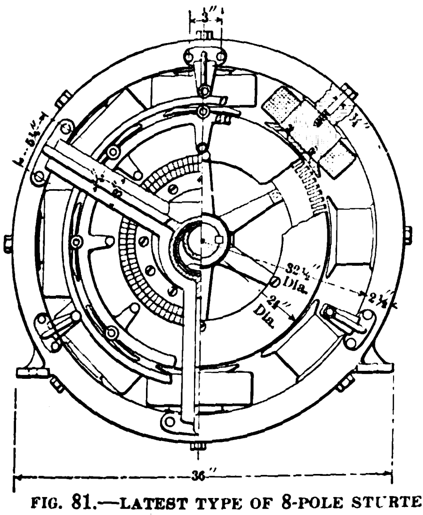



FIG. 79.—LATEST TYPE OF STURTEVANT BIPOLAR VENTILATING FAN MOTOR.—FIG. 80.

Fig. 83 illustrates a form of ventilating outfit used by the Sturtevant Company for heavier service. The motor here is an eight-pole machine, and, as the engraving shows, it is not enclosed at all. Figs. 81 and 82 show sectional views of the machine, from which it will be evident that the construction is an elaboration of that used in the bipolar machine. In these machines the field-magnet ring is of cast steel for medium sizes and cast iron in the large sizes. The field-magnet cores are of wrought iron and the pole shoes of cast iron, as in the bipolar type.



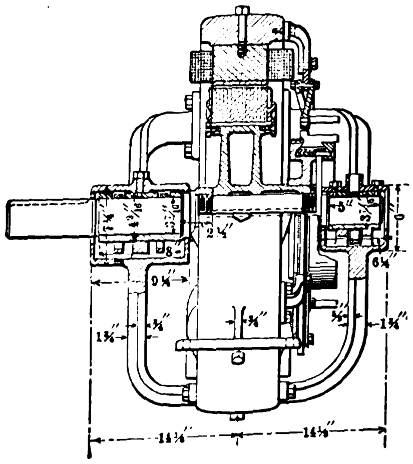


FIG. 81.—LATEST TYPE OF 8-POLE STURTEVANT VENTILATING FAN MOTOR.—FIG. 82.

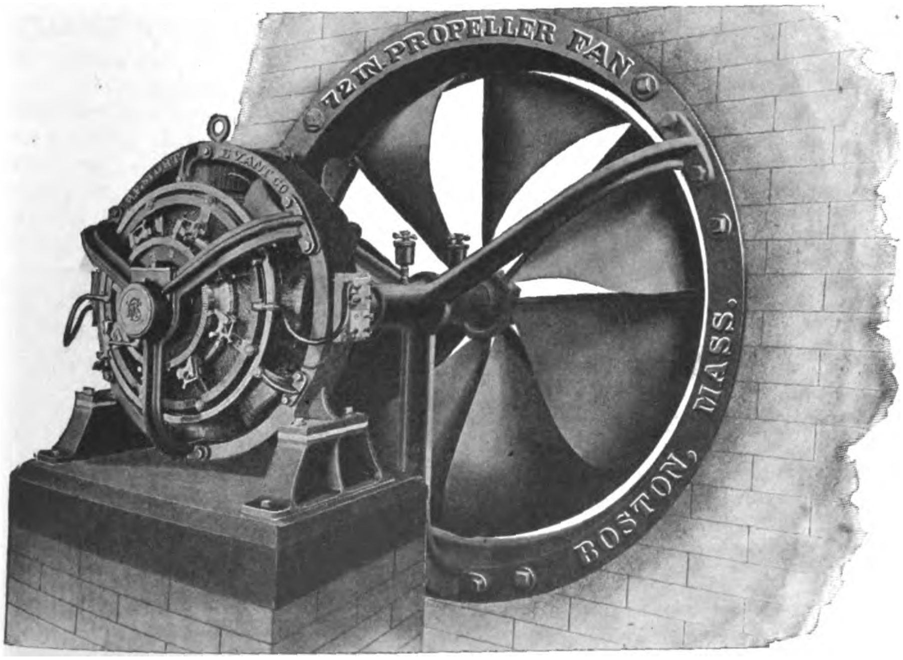


FIG. 83.—STURTEVANT VENTILATING FAN MOTOR OUTFIT.

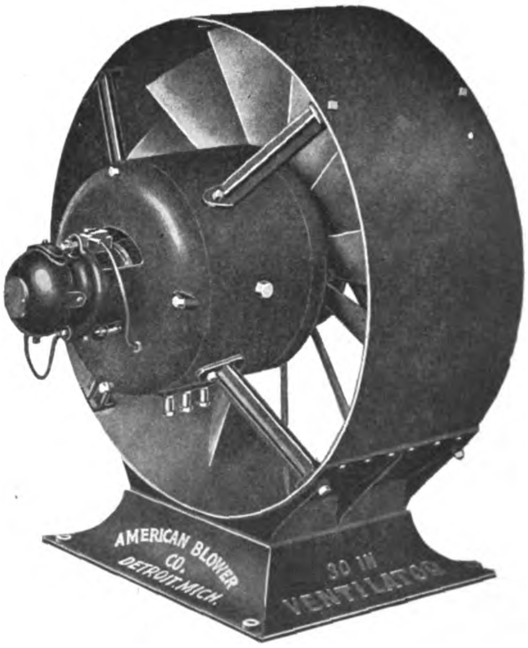


FIG. 84.—AMERICAN BLOWER FAN OUTFIT.

The field-magnet coils of both machines are, of course, form wound and individually insulated before being put in position. The armature core discs are clamped between end plates of a diameter equal to the extreme outside diameter of the core discs, and slotted to match the slots in the discs. By means of this arrangement, the teeth of the discs are clamped just as solidly as the body portions. Moreover, the teeth of the clamping rings are rounded at the edges, so as to avoid the possibility of cutting through the insulation and causing grounds or short-circuits.

The ventilating outfit of the American Blower Company, Detroit, Mich., is illustrated by Fig. 84, which shows this outfit to be of extremely compact construction. The motor is of the ordinary bipolar ironclad type, and is attached to the fan framing by four radial arms, as indicated in the engraving. The fan is mounted directly on the armature shaft, which is extended to a bearing on the other side of the fan. The hub of the fan extends within the casing of the motor, so as to reduce the distance between the bearing at the commutator end of the machine and the one on the other side of the fan to a minimum. The commutator is semi-exposed, the extension of the end cap on that side of the motor being cut away top and bottom for this purpose. The brushes are mounted, as the engraving clearly shows, in lugs at diametrically opposite sides of this extension.

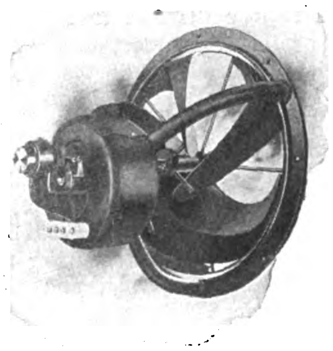


FIG. 85.—MASSACHUSETTS FAN MOTOR OUTFIT.

Fig. 85 illustrates the ventilating outfit of the Massachusetts Fan Company, Boston, Mass., in which a bipolar General Electric motor is used. The fan is built with a long central hub, to which the blades are attached at two points. It is also provided with a heavy wrought-iron ring around the outer edges of the blades, connected to the switch by five heavy radial braces, making it almost impossible for the fan to destroy itself if it should be accidentally driven at excessive speeds. The method of attaching the motor is obvious from the engraving, and as the machine is of the standard General Electric manufacture, a description of it is unnecessary.

Abstracts from Foreign Contemporaries

Differential Lock Nut.—Fig. 1, herewith, appearing in a recent issue of the London *Engineer*, shows a peculiar lock nut brought out by a West Australian engineer. The nut is made up of two parts, and the screw thread for the bolt goes through these two portions. The complete nut screws onto the bolt like an ordinary solid nut, but the two parts of the nut under discussion are screwed together with a thread of a pitch different from that of the bolt. When it is desired to lock the nut, the part which is up against the object to be held in place is held firmly while the upper nut is slightly unscrewed. This unscrewing cannot be carried on for more than half a revolution of the nut, since, in consequence of the difference in pitch of the screw threads, a jam soon occurs. As an additional safeguard, a small hole is drilled and tapped in the upper nut, as shown in the engraving, and a screw passing through this hole can be made to impinge on the upper surface of the lower nut, the object being to prevent the two parts from coming together and thus releasing the "jam." The nut, it is claimed, has been severely tested in West Australia in connection with mining machinery and has given a perfect lock.

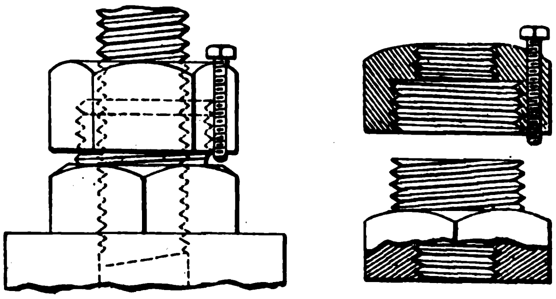


FIG. 1.—DIFFERENTIAL LOCK NUT.

Automatic Regulator for Pumping Engines.—London *Engineering* describes in a recent issue the automatic regulator shown by Fig. 2, for preventing a dangerous rise of pressure in a pumping engine. The regulator not only stops the engine should the pressure at the pump outlet exceed a fixed amount, but also starts the engine again when the presure falls. Should a main burst, so as to take all the load from the engine, the regulator immediately shuts off the steam. The apparatus consists of a piston valve, *D*, through which all steam has to pass on its way to the engine. This valve is connected by a rod to a water piston, *A*, which is acted upon by the water in the discharge pipe of the pumping engine entering through *E*. If this pressure rises, the piston is pushed downward in the water cylinder, gradually closing the steam valve and stopping the engine. As soon as the pressure diminishes the spring, *C*, returns the water piston to its normal working position, and opens the steam valve, *D*. The piston, *A*, rests upon a sleeve moving freely within the water cylinder, and held in position by the spring, *C*. Within the sleeve is a smaller spiral spring, *B*, which under normal working conditions is in compression. If the water pressure is suddenly reduced in the water cylinder, the spring, *B*, forces the piston, *A*, upward in the water cylinder, thus closing the port of the piston valve, *D*, and thus stopping the engine. When the water piston is in this position, with the valve closed by the bottom disc, the engine cannot be started until the piston, *A*, is moved back to its normal working position. To accomplish this a by-pass valve is provided, which makes communication between the two ports of the piston valve, and will pass a sufficient supply of steam to the engine to start it. This part of the apparatus is not automatic.

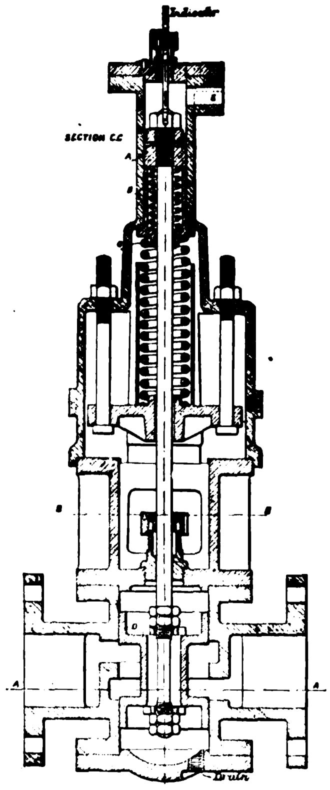


FIG. 2.—AUTOMATIC REGULATOR.

Drysdale Permeameter.—Many of the instruments devised for testing the magnetic qualities of materials are open to the objection that they require specially prepared specimens of the material to be tested. This is not only troublesome, but as is well known, different specimens of iron, however carefully prepared, may show considerable differences in their magnetic qualities, and what the manufacturer requires is an instrument which shall enable him to determine the magnetic qualities of any casting or forging before any large amount of time and expense has been spent upon machining it. Dr. Charles V. Drysdale, in a paper read before the Institute of Electrical Engineers, London, has adopted the plan of making the specimen and the greater part of the return path from the material tested. A drill of special form is employed, which cuts a hole in the specimen conical at the top, leaving a pin in the center of it, as shown by Fig. 4. The testing arrangement consists simply of a soft iron plug carrying a bobbin, on which are wound two circuits, a magnetizing coil and a search coil. As shown in Fig. 4, when the plug is inserted, a perfect miniature permeameter is produced, having an exceedingly good magnetic circuit, and in which either the permeability, retentivity, or hysteresis can be determined by the ordinary methods. For those who prefer to simply turn a handle and take a direct reading the instrument may be connected up as shown by Fig. 3. In this case a secohmmeter (henry meter) is used, and connected so that one commutator reverses the magnetizing circuit while the other reverses the search-coil

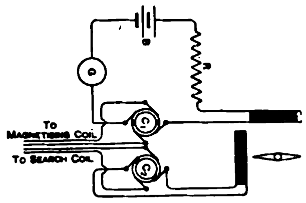


FIG. 3.—DIAGRAM OF CONNECTIONS.

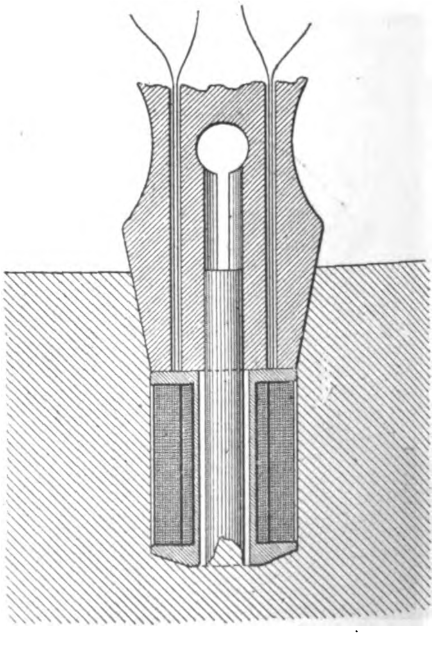


FIG. 4.—TESTING PLUG.

circuit. The magnetizing and search coils are each connected with one of the coils of an ohmmeter, and a magnetic needle will then give a reading depending on the permeability. Provision must be made, of course, for running the secohmmeter at a definite speed. A commercial form of the instrument is shown by Fig. 5, taken from the London *Electrician*. By means of this apparatus the permeability and retentivity are read off directly. It contains a battery of two large dry cells, a reversing key, *K*, a plug, *P*, connected by a quadruple flexible conductor, *C*, to a reversing key, *K*, and to a D'Arsonval, ballistic galvanometer, *G*, which is marked directly in values of the permeability. In order to obtain a test all that it is necessary to do is to drill the specimen, insert the plug and reverse the key. The pointer swings to the value of the permeability, and if the circuit is then broken and twice the second reading taken from the first, the value of the retentivity is obtained.

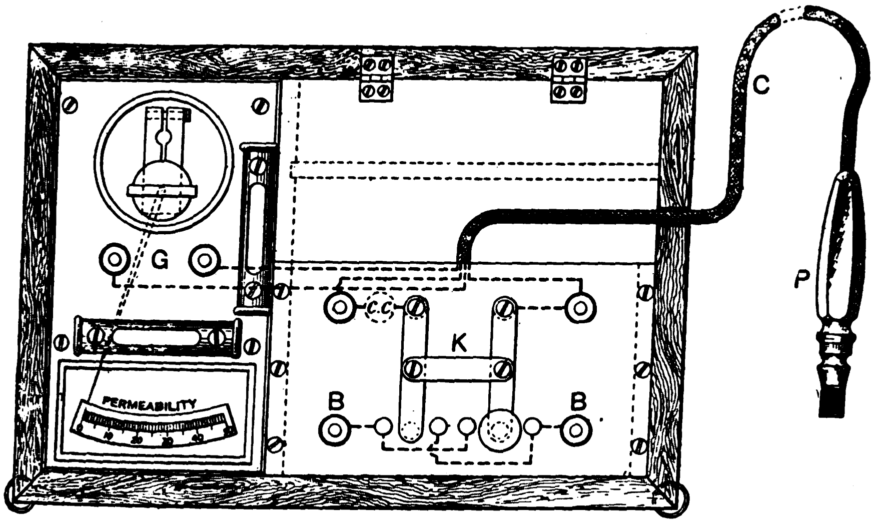


FIG. 5.—DRYSDALE PERMEAMETER.

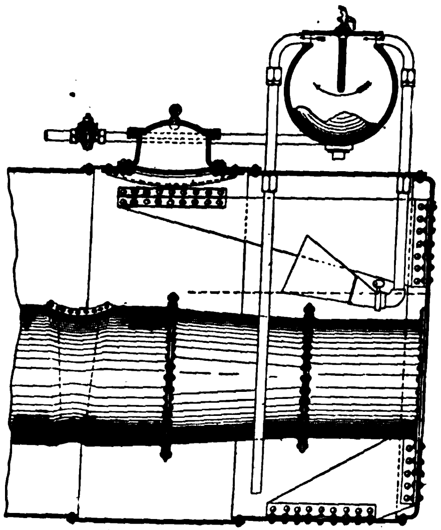


FIG. 7.—HOTCHKISS CLEANER.

Tumbler Switch.—A new form of switch, known as the "Century" tumbler switch, has been recently introduced in England and described in the London *Electrical Review*. Fig. 6 shows a two-way switch of this pattern, from which it will be seen that the contact bar, which is of insulating material, is double, and carries a copper bridge on the working end, which makes contact with two spring copper plates connected with the terminals. A novel feature consists in the mounting of the contact bar, which is controlled by two springs and is held in position by a fixed pivot passing through a metal-bushed slot in the contact bar. The combined action of the springs and slot results in a peculiar movement of the bar, giving a very quick break, and ensuring definite on and off positions. The handle is insulated from the conducting parts, and the latter are well separated from one another and from any back surface on which the base may be mounted.

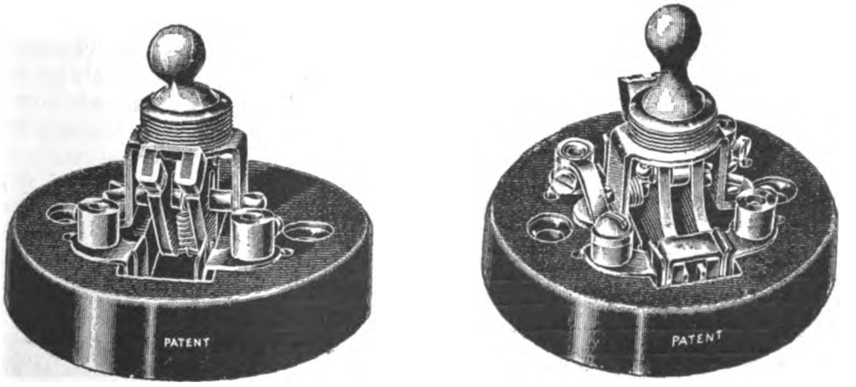


FIG. 6.—"CENTURY" TUMBLER SWITCH.

Boiler Water Cleaner.—Fig. 7, herewith, shows the Hotchkiss boiler water cleaner described in a recent issue of the London *Engineer*, by the use of which filthy water is made available for boiler feed. The apparatus consists of a large hollow iron sphere situated on top of a boiler and connected to the interior of the latter by two pipes, at the end of which is a funnel, mounted low enough for the edge to be just below the lowest working water-level, and as near as possible to the back end, with the mouth of the funnel toward the furnace front. The pipe connected to the funnel passes up through the shell of the boiler to one of three openings in the spherical reservoir, which has a baffle plate extending downward to the center of the sphere, as shown. The second opening in the reservoir is fitted with a pipe passing downward through the boiler shell to within 6 ins. of the bottom of the boiler. A blow-off is fitted to the bottom of the reservoir and carried to any convenient point for discharging. It is provided with an asbestos-packed blow-off cock and a reserve cock is fitted close to the reservoir. By filling the reservoir before lighting the furnace, circulation begins downward in the long pipe and upward in the pipe from the funnel within a very few minutes of starting the fire, and this circulation is said to continue after the fire is drawn, until the boiler is as cool as the surrounding atmosphere. By this means the floating particles of mud, grease, etc., carried up by the ebullition to the surface, are caught in the funnel and lifted into the reservoir, in which they are deposited by impinging upon the baffle plate and blown out from time to time. For the removal of oil in a fluid condition, or very light particles of deposit, an extra blow-off connection is attached to the top of the reservoir in place of the air cock. At first sight it might well be assumed that this skimmer, dealing only with surface water, cannot do much to prevent the formation of scale; but statistics given in connection with six boilers indicate that such an assumption is erroneous.

Improved Testing Tank.—In making prolonged tests on dynamos, it is invariably the case that the power generated cannot be usefully employed, but has to be dissipated by means of a wire or water rheostat; the use of the latter form of resistance becoming more and more prevalent, owing to its adaptability for any amount of current at any e.m.f., and the ease and fine gradation of adjustment. As is well known, the usual form of water rheostat consists of a wooden tank or barrel having two electrodes of large area to which are attached the positive and negative leads of the machine to be tested. The electrolyte consists of a solution of either common salt or of washing soda, the latter being preferable, since by its use the plates are not so apt to become furred. The current which flows will depend upon three things: the area of the electrodes (a constant quantity), their distance apart, and the strength of the electrolyte. This latter may also be made a constant quantity if means are taken to keep the temperature of the solution below the boiling point and its quantity unchanged, so that the problem reduces to the mere manipulation of the electrodes, which, when once set, should furnish a nearly constant load. A tank designed by H. Lindley, and described in a recent issue of the London *Electrical Review*, is said to fulfill these conditions. Mr. Lindley's arrangement consists of a wooden tank, which is made longer than is required by the size of the electrodes, which are horizontal. They are made of cast iron and are perforated with a large number of holes, the function of which is to allow a free circulation of the electrolyte, and also to permit the upper plate, which is adjusted by means of a screw, to be easily moved up and down. The electrodes occupy about one-third of the tank, the other two-thirds being taken up by a cooling arrangement as shown in the engraving. This latter arrangement is similar in construction to a water heater, and consists of a number of copper pipes connected in series with each other by return bends. Cold water is forced through these tubes, and the quantity is regulated by means of a valve, or a pump may be added if necessary to greatly increase the flow. The circulating water being clean could, if necessary, be used for boiler feeding or other purposes. In a test made with a rheostat of this kind 300 kilowatts were dissipated for six hours continuously, the temperature of the electrolyte remaining below 200° Fahr and the strength of the solution constant.

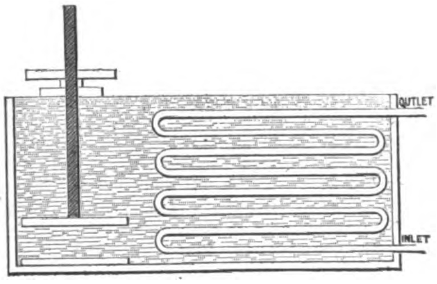


FIG. 8.—IMPROVED TESTING TANK.

Ricks Electric Accumulator.—The last number of the *Centralblatt fuer Accumulatoren, Elementen, und Accumobilen-Kunde* contains the results of a number of tests of the accumulator invented by Albert Ricks, of Berlin. These results are remarkable in that they purport to show that the capacity of the accumulator is quite double that of batteries of the usual construction. The important feature of the Ricks accumulator is that the active material—peroxide of lead and spongy lead—is absolutely detached from the metallic lead plates which collect and conduct the current. There is no attempt made to cause the one to adhere to the other, and therefore the usual trouble caused by the peroxide working loose does not occur. The foundation for the active material is a non-conducting plate, such as ebonite or celluloid, with which it is possible to secure firm union and which, at the same time, is not so heavy or rigid as the usual lead grid. The active material in granular form is cemented and pressed onto both sides of the plate, and, it is stated, adheres so firmly that it can scarcely be detached without breaking the plate. The lead conducting plate is very thin, and is pressed against the outer face of the active material by springs so as to be in intimate contact with a part of its surface. Holes are cut in the lead plate to facilitate the circulation of the electrolyte, and the length of the plate is made sufficient to enable it to serve for a positive electrode in one cell and a negative electrode in the next, the lead being bent over to the proper shape; burned connections between adjacent cells are therefore unnecessary. The tests included several small batteries. In the first of these the active material was spread to a thickness of 4 to 4½ mm. (0.16 in. to 0.18 in.), on celluloid ½ mm. thick and measuring 190 mm. by 160 mm. (7.6 ins. by 6.3 ins.). The lead conducting plate was ½ mm. (1/50 in.) thick. The total weight of the cell was 1.83 kg. (4 lbs.), and 30 ampere-hours were taken out in six hours at an average e.m.f. of 1.9 volts, giving 57 watt-hours, or 14 watt-hours per pound of battery. A second cell had plates 6.3 ins. by 7.5 ins.; its outer dimensions were 6.7 ins. by 10.2 ins. by 2.5 ins., and its weight 15.76 lbs., of which each of the positive and the negative electrodes was 4 lbs. The discharge at the rate of 6 to 7 amperes was 130.6 ampere-hours at an average of 1.8 volts, equal to about 245 watt-hours or 15.6 watt-hours per pound. The discharge curve is shown by Fig. 9. A third battery had two cells with three plates each—one positive, .629 in. thick, and two negatives, .3 in. thick. The discharge at the rate of 12 amperes was 140 ampere-hours at 1.85 volts or 259 watt-hours—being 19½ watts per pound of weight, including acid. The discharge curve is shown by Fig. 10. Finally, another battery of two cells was tested with five plates each. The spongy lead and the peroxide of lead each weighed 4.85 lbs. each, and the whole battery 21 lbs. The discharge at the rate of 11.5 amperes was 230 ampere-hours at 1.9 volts, equal to 437 watt-hours or 20.75 watt-hours per pound of cell. The discharge curve is given by Fig. 11.

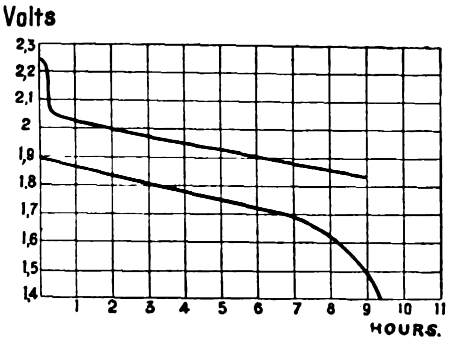


FIG. 9.—RICKS ACCUMULATOR DISCHARGE CURVE.

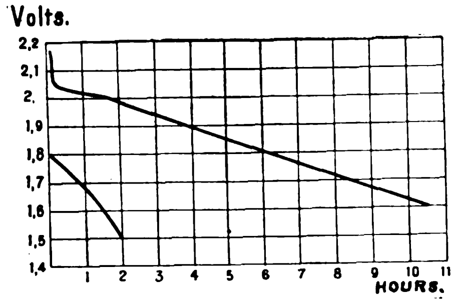


FIG. 10.—RICKS ACCUMULATOR DISCHARGE CURVE.

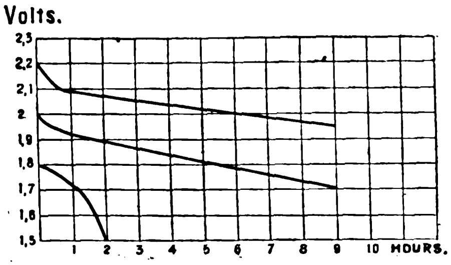


FIG. 11.—RICKS ACCUMULATOR DISCHARGE CURVE.

"Boreas" Hose-Coupling.—London *Engineering* describes a new form of hose-coupling, which can be used either for joining different lengths of hose pipes, or for connecting valves, cocks, nozzles, etc., to hose ends. Its construction will be understood on reference to Fig. 12, which shows a longitudinal section through the coupling, a section on the line *A A*, and an external view. The action of the coupling is as follows: The nipple, *B*, which may have either a plain threaded end, or be made for a union nut as shown, is inserted in the end of the hose; the end of the hose is then surrounded by a conical bushing, *D*, made in four segments and contained in a conical sleeve, *E*. The sleeve is enlarged into a bell-mouth, and it will be readily seen that when the nut, *F*, is screwed up, the cored segments, *D*, are forced inwards upon the end of the hose, compressing it around the nipple, *B*, and giving a tight joint. The advantages claimed are that the bell-mouth on the sleeve, *E*, prevents abrupt bending and the consequent damage of the hose; the hose is firmly compressed, and cannot be blown or pulled off the nipple, so that the coupling is thoroughly reliable for steam, air and hydraulic pressure. Two milled beads around the circumference of the nut, *F*, are provided to facilitate the removal of the coupling by hand.

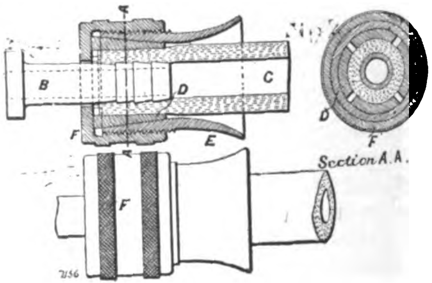


FIG. 12.—"BOREAS" HOSE COUPLING.

Fault-Testing Car.—A recent issue of the London *Electrician* describes a useful testing set made by Elliott Bros. for the Croydon electric works. The apparatus consists of a small portable battery, a standard resistance of one ohm, and a very accurate voltmeter of hign resistance, the method used for locating the faults being based on potential drop. An adjustable resistance is provided for keeping the battery current constant. Fig. 13 shows the application of the set when there is a short-circuit insulated from earth between the two conductors of a three-core cable; the first reading, V_1, is taken with the switch on the button, 1, and the second reading, V_2, with the switch on the button, 2. Then R, which is the resistance from the testing point to the fault, is equal to $V_1 \div V_2$. If the resistance of the fault is low compared with that of the voltmeter, one reading may be sufficient for an accurate result; if not, tests from the two ends should be compared and the average of the results taken. In Fig. 14 it is assumed that all three conductors of the cable have become grounded, a fault that might occur through continuity of a short-circuit or a mechanical injury. The voltages, V_1 and V_2, are taken as shown in the engraving, and the equation, $V_1 \div V_2 = R_1 \div R_2$, is employed to find the position of the fault. Although this result may be checked by the use of another core, the determination can only be deemed accurate if the resistance of the fault is so small as to be inconsiderable when compared with the resistance of the cables. In an actual case a fault in a 3000-yd. length of concentric cable was located first as being between two junctions 300 yards apart, and when these were opened a further test gave the result to within 3 yards of the actual spot.

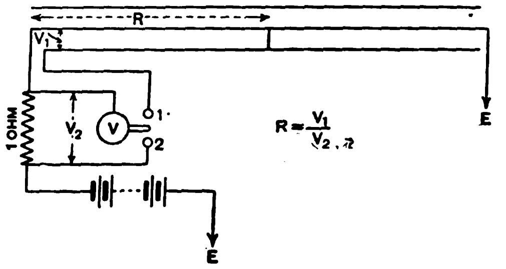


FIG. 13.—TESTING FOR SHORT CIRCUIT.

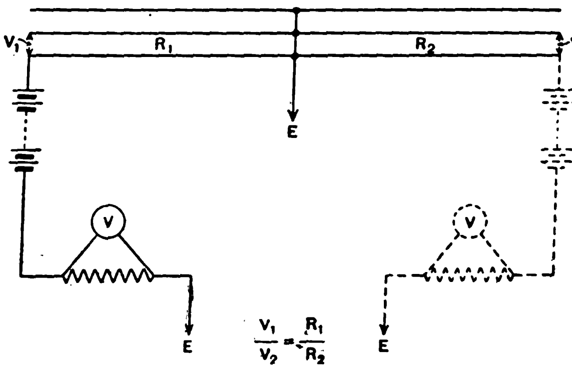


FIG. 14.—TESTING FOR GROUNDED CONDUCTOR.

Sulphate of Lime in Feed-Water.—In the May number of the AMERICAN ELECTRICIAN reference was made in this department to the experiments of M. Boyer-Guillon upon the solubility of sulphate of lime in water at various temperatures, and their important bearing upon the question of the purification of boiler feed water. Now M. Boyer-Guillon contributes a further paper to the *Revue de Mecanique*, detailing his experiments at length. Sulphate of lime, as is well known, forms a very hard and stubborn scale in steam boilers and its removal from feed water has been "a consummation devoutly to be wished." Carbonate of lime is readily precipitated by heat, being almost completely thrown down by heating the feed water to the boiling point, so that having a large feed-water heater with ample heating surface, and space and time given for settlement, the carbonate may be removed by the temperature attainable from exhaust steam. The temperature at which sulphate of lime is precipitated has been variously stated by different authors; the general idea being that this is complete at 300° Fahr., corresponding to about 52 lbs. pressure. The experiments of M. Boyer-Guillon, however, show that entire insolubility is not reached even at 392° Fahr., and also that the time element enters into the problem to an extent which should be taken into account in practice. He investigated first the cause of the change in solubility of sulphate of lime by heat, and, secondly, the temperature at which the action takes place. The method consisted in preparing a standardized solution of sulphate of lime in distilled water, in heating it to a recorded and uniformly maintained temperature, and in filtering it at this temperature, the precipitate being subsequently weighed. The precipitates were carefully analyzed, and the apparatus was thoroughly calibrated. The results may be stated as follows: The solubility of sulphate of lime in water increases from 32° Fahr. to 93°, at which point the maximum is reached. Thence it slowly diminishes until a temperature of 225° Fahr. is reached and the solubility then decreases more rapidly, although not uniformly, until at 392° Fahr. the solubility is 0.015 per cent. A feed-water temperature of 392° Fahr., corresponding to a pressure of 250 lbs., is not readily attained in an ordinary heater, but it is possible that in some form of special economizer the heat of the waste gases might be employed for this purpose, and practically pure water delivered to the boiler.

Some Recent Electrical Patents

Telephone Repeater.—The attempts to produce an industrially successful telephone repeater are legion, but thus far the solution of the problem remains in obscurity. One of the most recent attempts in this direction is based upon the same general principle as that of the familiar carbon granule transmitter, *i. e.*, the variation of circuit-resistance by varying the positions of carbon particles. This arrangement is the invention of Severn D. Sprong, and is illustrated by Fig. 1, herewith. Mr. Sprong's invention consists briefly of using a coherer-like tube containing small particles of iron, each entirely covered by a coating of carbon, this tube being mounted between the poles of a permanent magnet so as to give an initial magnetism to the particles within it, and the current impulses received from the transmitting line being passed through a coil wound about the tube. In the engraving the poles of the magnet are indicated by the letters C and C. A piece of soft iron, L, is bent into such shape as to afford a good return circuit for the magnetic flux set up by the coil wound around the tube. The circuit to which the impulses are to be repeated is connected through an induction coil to the terminals of the coherer-like tube, as shown in the diagram. The theory of the apparatus obviously is that the impulses of current coming in over the transmit-

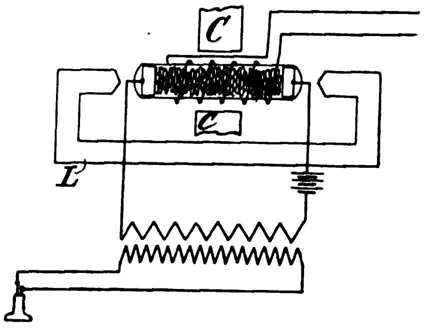


FIG. 1.—TELEPHONE REPEATER.

ting line will disturb the particles of iron in the tube so as to alter correspondingly the resistance of the receiving circuit, in series with which the particles are. It will be at once evident that even though the instrument might be operative, it is open to the serious objection that it will repeat only in one direction. Patent No. 692,553.

Multi-Filament Incandescent Lamps.—One of the latest methods of providing graded illumination from a single incandescent lamp is illustrated in Fig. 2, herewith, which is a cross-section through a form of lamp devised by Homer Garwood. The lamp, as shown in the engraving, is provided with three filaments, numbered 1, 2 and 3, all of different candle-powers. The left-hand ends of the filaments are all connected to a common terminal, *C*, and the right-hand ends are connected to individual curved spring terminals, 1′, 2′ and 3′. The curved ends of these terminals project into a chamber hollowed out in the lamp base, and are arranged so as to lie in the path of a plunger, *E*, which is normally held up by a coiled spring, *G*, which presses the plunger against a flat spring, *H*. Upon screwing the lamp into the socket the upper end of the plunger, *E*, comes into contact with one terminal of the lamp socket, and the lower end is pressed into contact with the spring terminal of filament No. 1. The common terminal, *C*, comes into contact immediately with a spring terminal in the lamp socket which allows the lamp to be screwed in and out for a considerable distance without breaking the contact at this point. It will be obvious that as the lamp is screwed farther and farther into the socket, the plunger, *E*, will be forced down and come into contact successively with the terminals of the filaments 2 and 3, so that by adjusting the position of the lamp in the socket either the No. 1 filament alone, or Nos. 1 and 2 filaments, or all three filaments, may be put into service. The spring, *H*, is circular, somewhat like the spring in the old-style push-buttons, so that it does not cover the common terminal, *C*. Patent No. 692,260.

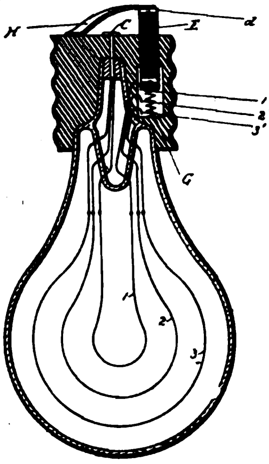


FIG. 2.—MULTI-FILAMENT INCANDESCENT LAMP.

Self-Ejecting Telephone Plug.—With a view to reducing the already greatly-reduced work of telephone exchange operators, and thereby facilitating the service, Charles F. Butte has patented a self-ejecting plug for telephone switchboards, which is illustrated by Fig. 3, herewith. The plug tip carries a sleeve which slides upon the shank of the tip and is normally pressed outward by a spiral spring contained in the handle of the plug. Upon pushing the plug into the jack, this sleeve is pushed back into the plug handle by the face of the jack and caught by the latch shown pivoted near the center of the handle. At the rear end of the handle is a small electromagnet adapted to draw the rear end of the latch downward and release the sliding sleeve. This magnet may be connected in the clearing-out circuit, so that when a subscriber hangs up his telephone the magnet is energized and draws the latch downward; the front end of the sleeve being already against the face of the switchboard jack, the spiral spring forces the plug out of the jack. Mr. Butte has also patented a method for automatically ejecting switchboard plugs, in which the plug is forced out by a mechanism mounted on the switchboard instead of in the handle of the plug. Patents No. 692,004 and 692,005.

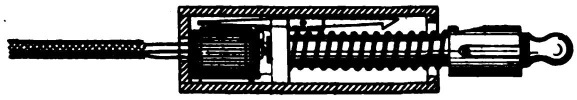


FIG. 3.—SELF-EJECTING TELEPHONE PLUG.

EFFICIENCY OF WATER WHEELS.

To the Editor, American Electrician:—

We note in your issue for December, 1901, an editorial on "Water Wheel Efficiency," in which you state that "occasional tests of water wheels have been made by users in the far West showing conclusively that a full-load efficiency of 80 per cent is not obtainable." We enclose herewith a copy of a letter from Prof. Carpenter which will indicate the high efficiency possible with Pelton water wheels.

THE PELTON WATER WHEEL COMPANY.
San Francisco, Cal.

PROF. CARPENTER'S LETTER.

Ithaca, N. Y., Oct. 15, 1901.

The Pelton Water Wheel Company,
San Francisco, Cal.:

Gentlemen: In accordance with your request for a statement in regard to results obtained in tests made by us on your wheel, I beg to say that we have obtained as high an efficiency as 88 per cent in some of our experiments on Pelton wheels.

We recently conducted a series of experiments in which we used various forms of buckets on the rim of the same wheel. The results of these tests seemed to indicate the superiority of the general form of bucket adopted in the Pelton wheel.

Very truly yours,
R. C. CARPENTER.

Sibley College, Cornell University.

[We are glad to note the high efficiency obtained in Prof. Carpenter's tests, but we may add that the editorial mentioned had reference only to ordinary conditions of practical operation. It is, of course, possible that the test conditions obtained by Prof. Carpenter may be at times duplicated in power-plant practice.—EDITOR.]

THE SIZE OF TELEPHONE SWITCHBOARDS.

To the Editor, American Electrician:—

In the January copy of the AMERICAN ELECTRICIAN there appeared an article under the signature of Mr. F. J. Dommerque, entitled "Telephone Engineering." While the article is very interesting, it contains some statements to which the undersigned desires to take exception. Mr. Dommerque states that there is at the present state of the art, referring to telephony, no difficulty in supplying 90,000 subscribers from a single office, it being possible to build a switchboard for that number of subscribers by arranging the jacks on ¼-in. centers. Let us analyze this and see what results we get.

Every up-to-date telephone engineer knows that all the subscriber lines entering the switchboard must be brought within the reach of every operator; no operator is able to reach over a space of greater than 70 ins. horizontally. In 70 ins. 280 jacks may be mounted; dividing 90,000 by 280, in order to find the number of rows vertically, we get 322. Therefore we would have 322 rows of 280 jacks each, and since these are also on ¼-in. centers, the height of the multiple would be 322 ÷ 4 = 80½ ins., providing there are no stiles to split the jacks up in panels, as is the usual practice to-day. This also takes no account of the answering jacks and lamp signals, which will also occupy some space below the multiple jacks. The question seems pertinent: How does Mr. Dommerque propose to bring every jack within the operator's reach?

In the same article reference is made to certain switchboards said to have a capacity of 20,000 lines. Modern construction requires a two-wire system, and does not tolerate any longer a three-wire system, or two wires and a ground return. No one knowing the service given on these four-division boards, which have for signals polarized drops of a diminutive type, manually restorative, susceptible to static discharges, also local battery subscriber's instruments with four push buttons, kick coils, and about half a hundred springs, would think of putting in such a plant and calling it modern. The fact that such have been installed in two large exchanges does not go to show anything at all.

While every progressive telephone engineer will hail with pleasure all advances made in the art, Mr. Dommerque's statements are so much ahead of everything heretofore accomplished in telephone work as to justify one in considering them more visionary than practical.

WM. MEYER.

Chicago, Ill.

NOTES.

Address Wanted.—We have received several letters signed "Jack Haines" and dated from St. Louis, and all replies to such letters have been returned to this office with the endorsement that the post office authorities are unable to make delivery. Mr. Haines will greatly oblige us by sending us his full street address.

A Sunbeam.—The following gem is taken verbatim from a recent issue of the New York *Sun*:

> "Please state if there is any known substance or combination of substances that will obstruct the attractive power of the magnet. I mean, any substance through which that force will not penetrate.
>
> J. J. T.
>
> Copper and brass will do so; that is why they are used in making compasses."

"If you see it is in the *Sun*, it's so." Hereafter, all compass needles mounted in brass cases will have to get along without the earth's magnetism, and guess at the location of the North Pole.

Disastrous Fire From an Obsolete Type of Car Heater..—Early in February a fire was started in the car barn of the Paterson (N. J.) Street Railway Company which spread under the influence of an unusually strong western wind until property was destroyed to the extent of about $10,000,000. The cause of the fire was a coal stove in one of the old cars of the company which had been run into the car barn and left without proper attention to the fire in the stove. Notwithstanding the facts in the case, the *New York Herald* took occasion to direct the matter and attempted to lay the blame for the conflagration upon "the defective insulation of electric feed wires."

The Metric System Recommended.—The Franklin Institute, of Philadelphia, Pa., recently appointed a special committee to consider the advisability and feasibility of the adoption of the metric system throughout the United States. This committee reported last month as follows:

"Whereas, It is desirable to obtain an international standard of weights and measures, also to simplify and regulate some of our existing standards; and, whereas, the metric system is commendable not only as a suitable international standard, but also for facility of computation, convenience in memorizing and simplicity of enumeration; Resolved: That the Franklin Institute approves of any movement which will promote the universal introduction of the metric system with the least confusion and expense. Resolved: That the national government should enact such laws as will ensure the adoption of the metric system of weights and measures as the sole standard in its various departments as rapidly as may be consistent with the public service."

Among the signatures are those of a number of prominent engineers, including James Christie, of the American Bridge Company; Wilfred Lewis, president of the Tabor Machine Company, and S. M. Vauclain, superintendent of the Baldwin Locomotive Works.

American Electro-chemical Society.—Arrangements have been made for the inaugural meeting of the American Electro-chemical Society, to be held at Philadelphia, beginning on the evening of April 3 and continuing through April 4 and 5. The first evening will naturally be devoted to organization, and after this is completed several papers will be read and discussed, experimental demonstrations made, and notable installations in the vicinity visited. Thus far 294 charter members have been enrolled.

Scranton Engineers Club.—At the annual meeting of the Engineers' Club, Scranton, Pa., held recently, the following officers for the ensuing year were elected: President, H. H. Stoek; vice-president, B. F. La Rue, Professor of Civil Engineering in the International Correspondence Schools; secretary, A. E. Lister; treasurer, F. J. Platt; corresponding secretary, A. B. Dunning; librarian, H. M. Lane, Professor of Mechanical Engineering in the International Correspondence Schools; directors, W. M. Marple, C. C. Rose and H. W. Rowley. President Stoek is the editor of *Mines and Minerals*, the well-known mining periodical published in Scranton.

Library of the American Society of Mechanical Engineers.—The library of the society, which is located at its headquarters, No. 12 West Thirty-first Street, New York, contains one of the best collections of engineering literature in the city, and is especially well equipped with proceedings of the technical societies of this and foreign countries, as well as the current technical literature of the world. Among recent additions made to the library we note the following books: "American Telephone Practice," by Miller; "Chemistry for Engineers," by Blount & Bloxam; "Compressed Air," by Hiscox; "Development of Water Powers," by Frizell; "Dynamo-Electric Machinery," by Houston & Kennelly; "Electric Lighting," by Crocker; "Electric Tramways," by Dawson; "Elements of Electrical Engineering," by Steinmetz; "Gas Engines," by Hiscox; "Induction Coils," by Allsop; "The Induction Motor," by Behrend; "Law of Contracts," by Wait; "Locomotive Construction," by Meyer; "Mill Construction," by Tyrell; "Potentiometer," by Fisher; "Practice and Theory of Frame Structures," by Johnson; "Railway Handbook," by Herrick; "Steel Ship Construction," by Walton; "Street Railway Motors," by Hanchett; "Testing of Dynamos and Motors," by Parham & Shedd; and "Wireless Telegraphy," by Lodge. The library is open to the public between the hours of 10 a.m. and 10 p.m.

A "Pleasing" Experiment.—Lieut.-Col. R. E. B. Crompton, the well-known English electrical engineer, is the author of a very interesting sketch relating some of his experiences in early electrical days, which sketch was published in the London financial paper, *Electrical Investments*. Among the many amusing incidents related by Colonel Crompton was the following:

"On one occasion, Dr. Wm. Siemens was lecturing on arc lamps at the Royal Institution, and in those days it was the custom to work lamps with very short arcs. Owing to the fact that it was not appreciated that 45 volts were necessary for arc lamps, makers only allowed 35 volts, so that the lamps were always fizzing and hissing and forming 'mushrooms' or 'cauliflowers' on the negative carbon. Dr. Siemens was lecturing on the arc lamp, when one of these cauliflowers fell off one of his own lamps onto the center of his head—which was bald—and produced a most remarkable effect. I do not think the Royal Institution ever witnessed a more pleasing experiment."

Official Recommendation of Electrical Equipment for the New York Central—The New York State Railroad Commission has made a report on the accident which occurred in the New York tunnel of the New York Central & Hudson River Railroad Company, and which was referred to editorially in our last issue. The commission, in its report, states that electricity is the most desirable form of motive power for use on that part of the company's railroad system, and points out the cramped condition of the railway company's New York yards, and the need for increasing the yard facilities so as to avoid the necessity of carrying nearly all of the traffic over only two tracks for a distance of several hundred feet. The report of the commission further reads as follows:

"The railroad company has felt this need for at least three years past, and it has been the subject of much public discussion, more particularly in connection with the intolerable atmospheric conditions which affect passengers in passing through the tunnel in the summer. The rejoinder of the officials to this criticism has been that the required real estate for the enlargement of the yards could not be obtained, and that as to electricity there was then no feasible system by which the volume of traffic could be handled. Now, however, partly owing to its awkward sense of its own business necessities and partly to the recent rapid advances in electrical engineering, the company has been forced into bringing forward a plan for improvements which will embrace an increase of the yard room and the separation of the suburban traffic from the through traffic by carrying suburban trains underground from the tunnel by a loop system to an independent station, and operating the local trains by the multiple-unit electric plan."

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

Vol. XIV. MARCH, 1902. No. 3

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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Fan Motors for 1902.

As pointed out at the beginning of the fan motor article on another page, the motor part of the modern breeze creator had been previously developed to such a point as to leave no room for startling progress in the construction of this year's motors. Consequently, all of the improvements and new features are found in the purely mechanical parts of the machines. The full significance of this state of affairs does not at once dawn upon one. What it means is that these little motors have been brought to such a degree of excellence that they will operate continuously, day in and day out for months, in dusty and fairly damp surroundings, and without any attention whatever after once filling the oil cups and brush holders. A grindstone, if used as continuously, would require truing up oftener than a fan motor requires attention.

◆

The Metric System.

As noted on another page, the Franklin Institute has recommended the adoption by the United States Government of the metric system. The principal argument in favor of such action is that every civilized country in the world except this one and Great Britain uses the metric system; consequently, its adoption by this country would greatly facilitate international commerce and extend the international character of scientific terminology. The chief argument against the metric system is that the natural mental process in making computations is to divide everything by two—a unit being divided into halves, quarters, eighths, sixteenths, etc.—and that the metric system is not based on this natural human propensity, being a decimal system. This argument is a very academic one, notwithstanding its supremely practical basis. Our monetary system is decimal, but no difficulty has been found in dividing the fundamental unit (the dollar) into halves and quarters. Moreover, it is indisputably true that a reasonable experience with any system of measures will render the use of the system automatic and fluent. It is natural for human beings to convey food to the mouth by means of the fingers—watch any three-year-old eat unrestrained—but it does not require an enormous amount of education to counteract that tendency.

Even if the natural tendency to bisect quantities be considered as an important factor, it would justify only a part of our present units of weights and measures, notably the inch, pound and bushel. To be consistent in this view, the yard should contain either two or four feet, and the foot should contain eight, sixteen or thirty-two inches. Similarly, the mile should be divided into 2048, 4096, 8192 or some other number of feet that would make the foot or the yard the result of successive halvings, and there should be 32 gallons in a barrel. The fact that although these very mixed standards are not consistent with the bisecting theory, they have been used for years without much difficulty, is ample confutation of the claims made for the "natural tendency." In order to conform to this tendency, most of the present system of weights and measures would have to be revised, causing the same confusion and detriment to manufacturers that would be entailed by changing to the metric system. And after it was all over we should still labor under the disadvantage—as we do now—of having a system that would not be smoothly interoperative with any foreign system, and one that would hamper export relations, just as the present system does, by reason of the refusal of foreigners to learn it and the consequent necessity for conversion into their system.

Next in importance after the international feature of the metric system comes the ease of computation. It is obviously much easier to convert centimeters into meters than it is to convert inches into feet or yards; in the first case one merely points off two places of decimals, while in the other division by 12 is necessary, of course. But the chief facility comes in the transition from one set of measures to another. Thus, a cubic centimeter of water weighs just one gram at maximum density; a liter is a cubic decimeter, and so on. And the bisecting practice can be, and is, applied within reason to the metric system; it is quite common to speak of a demi-kilogram, which is very nearly equal to our pound.

A sudden change to the metric system would undeniably be tremendously expensive and troublesome at the outset to American manufacturers, and this would seem to be by far the greatest drawback to its adoption. It is claimed by advocates of the change that it could be effected so gradually that no serviceable machinery and tools would need to be sacrificed, and whatever expense there might be would be distributed over a period of such length as to make it practically unfelt. At best, however, the inconvenience would be enormous; but the benefit to international commerce and engineering would appear to be incalculable.

District Central Stations.

As we intimated in the issue of last June, the interests of small central stations throughout the country can be vastly better served by combining the generating equipment of several neighboring plants in a single power house than by struggling along independently under enforced conditions which would render success difficult even with far abler engineering talent than such stations are able to command. With the transmission facilities afforded by polyphase alternating currents, it is a simple engineering feat to establish a single generating plant near the center of a group of small towns and transmit power to all of them at a line loss below that ordinarily imposed upon the main feeders of a small direct-current station.

For such a purpose any of the relatively low transmission potentials of from 10,000 to 15,000 volts would be suitable, and such potentials have the great advantage that step-up transformers are unnecessary; it is now conventional practice to build stationary armatures to yield 12,000 volts at the terminals of each phase or division. As to the "increased danger" to station attendants, urged by a few timid souls, this is not worth considering; 12,000 volts will not kill a man any "deader" than 2200, which is commonly employed, and while it will puncture insulation that would withstand the lower e.m.f., it is scarcely necessary to point out that there is no reason why an attendant should put himself within striking distance of high-potential conductors in a modern station.

The real factors in the case do not include the element of personal danger. They are restricted to purely engineering questions, and these are, in the light of modern practice simple ones. Any peculiarities in the local demands as to the character of service would obviously be cared for in the selection of the substation equipment. In many places direct-current service is not required, and in such places the sub-station would be merely a small room containing transformers and a small switchboard. The whole scheme is so thoroughly feasible that there is really no excuse for the continuance of independent operation by plants too small to be operated properly.

A goodly number of such combinations have already been effected, a notable example of which is the district station at New Rochelle, which is described in our leading article. A set of conditions more favorable to the district-station plan could scarcely have been made to order. But there are hundreds of small plants that are not nearly so well grouped as these three were, and are yet susceptible of combination by twos, threes, or even greater numbers, in similar manner, except as to the potential of the transmission feeders. The sooner the owners and managers of such plants awake to the possibilities of concentration, the sooner will their profits begin, or increase, as the case may be. And when a combination of the kind under discussion is effected it should be borne in mind that half-way measures do not pay. The generating equipment should be of the most modern type; the transmission potential should not be restricted and the district station equipment mongrelized by a weak-minded policy of transferring to that station apparatus that is obsolete as to type or inadequate as to e.m.f.

Municipal Ownership

We heartily congratulate the city of Worcester, Mass., upon the quality of timber of which its aldermanic body is made up, as manifested in a recent report by that body on the subject of municipal ownership. We also commend to the attention of those who advocate this principle the facts in this case. For the purposes of the present discussion these may be summarized thus:. Assuming that the existing plant at Worcester could be operated as economically by the city as by the private company (which has never been shown to be true in a single actual case thus far), the cost of operation alone—without taxes and depreciation—would be $124,000 a year; adding to this the sum of $151,200 required by a sinking fund, interest and depreciation, it would cost the city $275,200 a year to run the plant. The total receipts of the plant last year were $236,000, or $39,200 less than it would cost the city to operate it! Moreover, the electric light company now pays city taxes to the extent of $8,000, which would be extinguished if the plant were bought by the city, making the total deficit $45,000 a year. This is a somewhat high premium to pay just for the fun of running your own electric light plant, and the Worcester aldermen had the good sense to analyze the case and make this discovery "before" instead of "after."

In most towns and cities it is only necessary, in order to precipitate a most irrational and strenuous agitation in favor of muncipal ownership, for some irresponsible "expert" to gain the ear of a would-be prominent member of the city's governing body and paint in glittering colors the great saving that the municipality would effect by operating its own electric light plant; also the immense reputation that would accrue to the aforesaid city "father" if, by his efforts, such a policy were adopted. In not a few cases, lubrication is resorted to; in every case, the "expert" possesses a large and very dull axe. Such a man would have had an extraordinarily hard time in Worcester. When muncipal ownership is the result of the method just outlined, or any kindred method, it is invariably a failure. The conditions under which the plan is consummated are inimical to success. And even in cases where municipal operation has been undertaken in engineering sincerity, the results rarely come up to even the most conservative expectations. The reasons for this have been pointed out and reiterated so often that there is not the slightest need to go over the ground again now.

If all electric lighting companies could be brought to realize that any argument in favor of secrecy in the matter of earnings is a miserable fallacy, the municipal ownership sophistry would be forever dispelled wherever competent station management prevails. Moreover, "private deals" and jobbery of all sorts would be infinitely more difficult, and much more liberal franchises could be obtained. Thus, if a company made public annually a detailed report of its affairs, and contracted to pay to the city for its franchise a certain proportion of all net earnings beyond a given percentage on its investment, an absolutely exclusive franchise would be obtainable, and this would justify making many improvements and refinements in plant equipment, of such a character as to increase the margin of profit. Most of such improvements are utterly prohibited by the wretched hand-to-mouth arrangement now in force in so many of the smaller cities, to say nothing of the cut-throat competition that is from time to time engendered by a popular delusion that the business of the established company is a bonanza.

DESIGN FOR AN ELECTRIC MOTOR CYCLE.

THE FRAME.

BY J. C. BROCKSMITH.

At present all efforts to produce a successful motor cycle appear to be directed toward adapting small gasoline engines, or "hydrocarbon motors," as they are sometimes called, to this work by reducing their weight and at the same time increasing their speed in order to obtain the large output per unit of weight which is necessary in motor-vehicle work. To those who have had experience with other forms of motive power, the electric system will appeal on account of its absolute reliability, simplicity and ease of control, its noiselessness and smooth running qualities, the absence of heat, odor and vibration in the propelling mechanism, the self-starting quality of the motor, and its great overload capacity.

The machine which is here described and illustrated is based in its design upon a machine of similar construction which has been in successful operation for a period of about one year. It is designed for use particularly in cities, for there charging facilities and good roads may be found on every hand. It will run at a normal speed of 12 to 14 miles an hour, depending upon the load and road conditions. It will carry one or two riders, and with the latter load will give a minimum mileage on one charge of the battery of 25 miles. With one rider it will run, with the normal gear ratio, 14 miles an hour and give about 35 miles on one charge.

Considerably higher speeds than the above can be obtained, however, by making suitable changes in the gear ratio, as, for instance, by changing the sprockets on the rear axle or on the countershaft, or by shunting the series fields by means of a switch and resistance. Higher speeds than the normal are only obtained, of course, at the expense of efficiency, which means a lower mileage capacity, due to the higher rate of discharge of the battery. It is quite possible to attain speeds as high as 45 miles an hour by discharging the battery at the rate of from 60 to 70 amperes. This rate could only be maintained for short intervals, however, as the battery would be completely discharged in 15 to 20 minutes at this rate. Extremely high speeds are neither necessary nor desirable, and the above figures are given merely to show what can be done, but not recommended.

Fig. 1 shows a side elevation and plan view of the machine complete, with the exception of handle bars and saddles. It will be noted that the lines, angles and proportions of the regulation single-steering tandem have been adopted as far as possible, in order that no very great amount of extra labor shall be necessary, and that standard fittings may be used at most of the joints in building up the frame. The frame is practically a tandem frame, to which has been added a pair of tubes forming the lower members of the frame, which reach in one continuous length from the head to the rear axle boxes. These "reaches," as they will be called, are made of 1-in. 20-gauge tubing and run parallel with each other under the battery box and motor, so as to support the entire weight of the electrical equipment. In this manner the weight is placed very low, adding to the stability of the machine. Near the forward end of the battery box the reaches are bent upward to enter the head fitting and just back of the motor they are again bent upward to make connection with the rear bearing boxes. The parts of the machine which are required to support the load of both riders and motor equipment, are, therefore, the front forks and the front and rear wheels, and these have been made specially strong, in order that they may safely carry the load.

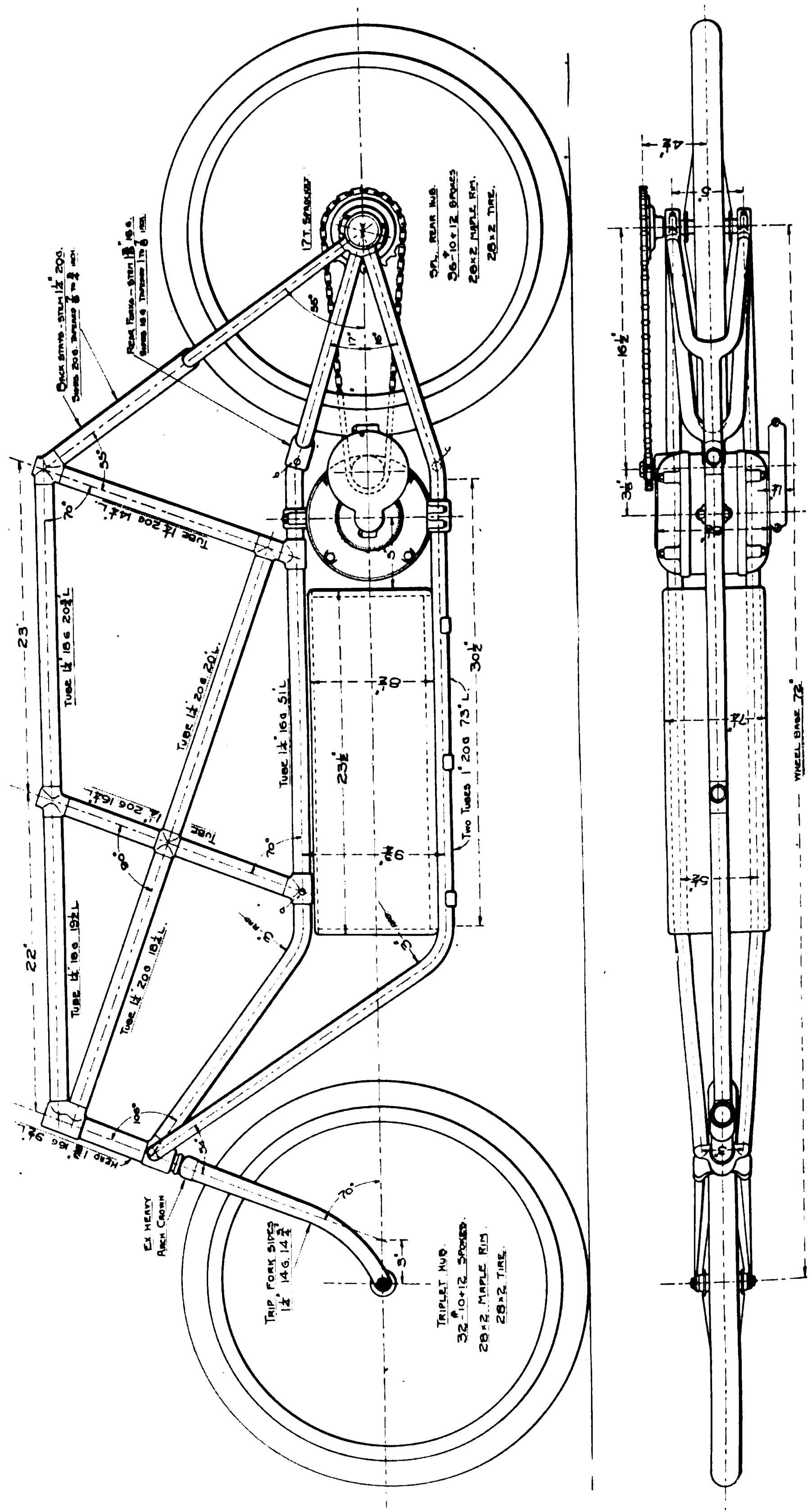

FIG. 1.—SIDE ELEVATION AND PLAN VIEW OF AN ELECTRIC MOTOR CYCLE.

The front forks should be triplet or "quad" forks, and the crown an extra-heavy drop forging. The wheels are to be furnished with No. 10 and 12 gauge spokes, meaning, of course, that the end portions of the spokes are No. 10 B. & S. gauge, while the center portion is swaged to No. 12. The rims should be substantial 2-in. maple rims, drilled for 32 spokes front and 36 spokes rear. Two-inch pneumatic tires are to be used, and these should preferably be of the thick-wall variety, in order that danger of puncture may be reduced to a minimum. The front hub should be a triplet or "quad" hub, with at least a ⅜-in. axle and ¼-in. balls and drilled for 32 spokes. The rear hub is special and will be described later.

The longest standard head (9½ ins.) has been adopted in order to give the riders as much leg room as possible. The head tube is 1⅝-in. (outside diameter) tube of No. 16 gauge. The head stem should be 1¼-in. extra heavy tubing with bearings to correspond. Some special fittings are necessary at the head, and these are shown in detail in Figs. 2 and 3. The lower head fitting is adapted to take three tubes, a 1¼-in. 16 gauge in the center and two 1-in. 20-gauge tubes at the sides. Flush joints are used here. The upper head fitting is for two tubes, one 1¼-in. 18 gauge and one 1¼-in. 20 gauge. All special fittings shown in Figs. 2 and 3 are to be steel castings. The lugs can, of course, be made hollow instead of solid, as they appear in the drawing, which would reduce their weight considerably.

The remaining portions of the frame are of ordinary construction. Flush joints are used throughout, with the exception of one or two places where, in order to preserve the continuity of a tube, a lap joint has been adopted. All lengths, diameters and sizes of the tubes constituting the frame are specified in Fig. 1, and it will, therefore, not be necessary to repeat these here. All fittings other than those detailed as special are of ordinary standard sizes. The rear forks and stays are of the usual pattern, and may be procured ready-made from any good supply house. There are, of course, no pedals necessary on this machine, since the motor is self-starting, and this in itself greatly simplifies the construction of the frame.

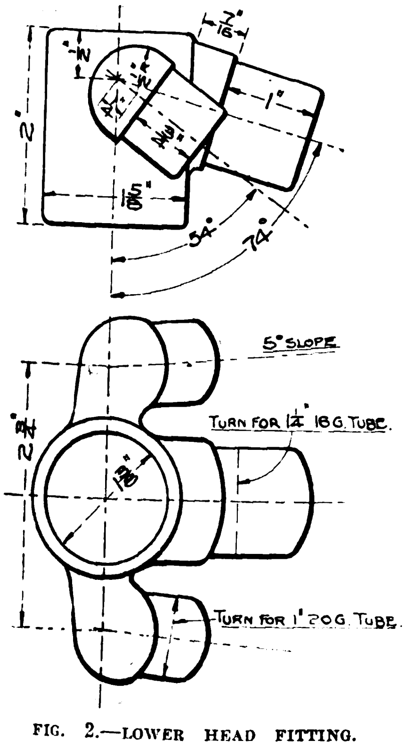

FIG. 2.—LOWER HEAD FITTING.

No handle bars or saddles are shown in Fig. 1, it being understood that the builder will select for himself some substantial and comfortable type of both these articles which best suits his taste. The front handle bars are, of course, to be clamped into the head stem, while the rear bars, being merely dummies, are clamped to the top tube of the frame by means of handle-bar clamps of the ordinary pattern provided for that purpose. The saddles are to be provided with seat posts, and these are inserted and clamped into the seat-post clusters in the usual manner.

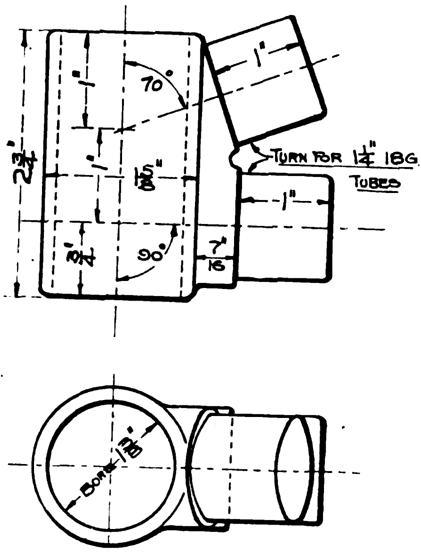

FIG. 3.—UPPER HEAD FITTING.

The plan view of the complete machine (Fig. 1) shows the parallel reach tubes located underneath the battery box and motor, and placed at a distance of 5½ ins. apart between centers. This view also shows the location of the rear sprocket and chain outside the forks, making the rear axle a revolving member, which is an unusual feature, and allows the use of a motor having considerable width, without, however, making special rear forks and stays necessary, as would ordinarily be the case. The wheel base, which is indicated in this view, is from 2 to 4 ins. greater than in the ordinary pedal-driven tandem.

Fig. 4 shows the details of the rear bearings, hub and sprocket on a larger scale, and serves to make clear some points which could not well be shown in the general drawings of Fig. 1. The rear hub and axle are to be turned in one piece from steel, and if a good steel casting can be obtained it will be preferable to employ this material, inasmuch as it would save a considerable amount of machining which would be necessary in case the piece were turned from mild steel bar.

The axle is ¾ in. diameter at the bearings, ⅞ in. between bearings, and has two flanges, each 2¼ ins. diameter, drilled to receive spokes. The tapered end of the axle is provided with a 3/16-in. key 1 in. long. The other end of the axle may be terminated inside its box, or, if considered desirable for any purpose, it may project some distance outside the box. The axle may be lightened considerably by drilling a ½-in. hole into the center, starting at the short end of the axle and terminating the hole at the other end where the tapered portion begins. The saving in weight will hardly justify this proceeding, however, and it is not recommended, particularly if a steel casting has been used.

The bearings themselves are what are known as "grooved ball shaft bearings," and are of a standard size and type which can be procured ready made from any of several manufacturers of ball bearings. They consist of three hardened tool steel races and a set of 13 balls 5/16 in. in diameter. One of these races is in the form of a spool, which is made a tight fit for the shaft and forced on under pressure. Of the other two races one is made a close fit for the casing and is pressed in, while the other is provided with a screw thread engaging similar threads in the casing, which affords a means of adjusting the bearing.

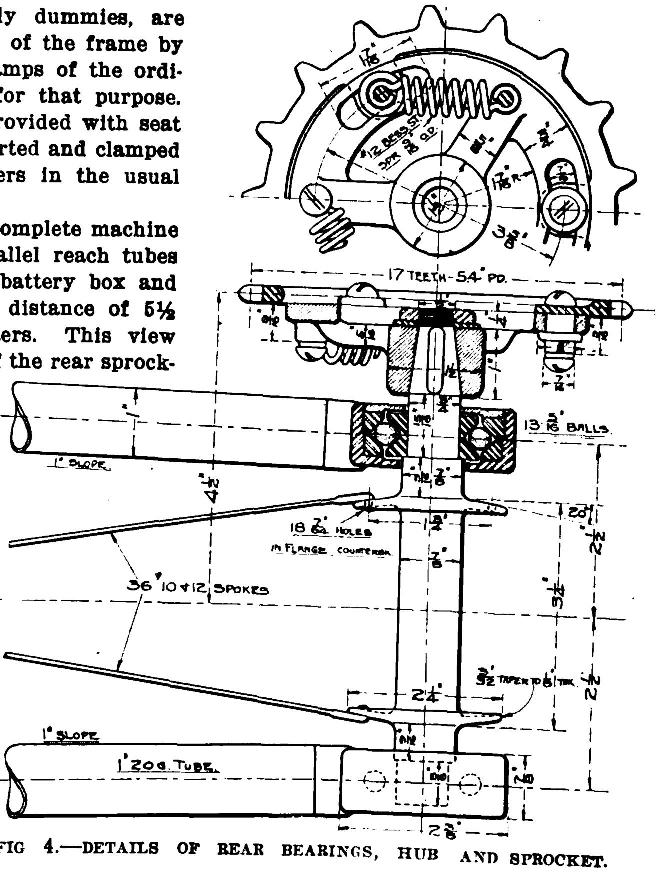

FIG 4.—DETAILS OF REAR BEARINGS, HUB AND SPROCKET.

It will be noted that the bearing is mechanically correct, for the balls bear at four points, each pair of which lie in a line perpendicular to the shaft. Only true rolling friction is therefore developed, and rubbing and sliding of the balls, common to other forms of ball bearings, is entirely avoided. Fig. 5 shows the case for the rear axle bearings. The case is bored and threaded to suit the steel races, and is parted to allow of assembling the pieces without trouble. The two halves of the case are fastened together by screws. Three lugs are provided for receiving the ends of the forks, stays and reaches.

In Fig. 4 will also be seen the details of the rear sprocket and method of spring driving. The sprocket is not mounted rigidly upon the rear axle, but is flexibly connected to a three-arm spider, which in turn is keyed to the axle. The sprocket itself is a mere rim upon which are cut the teeth. This rim is provided with three ears projecting inwardly, to which are fastened, by means of machine screws, short studs which pass through slots in the face of the spider. Three closed coil springs connect the ends of these studs with lugs cast on the spider, the springs being, of course, at the back, where they are not much in sight. The object of this arrangement is, of course, to avoid the strain upon the transmitting mechanism when current is turned on the motor. Where the parts are rigidly connected this strain is considerable, and has the effect of loosening the gears and sprockets upon their shafts. With the arrangement shown the motor armature can make two complete revolutions before the springs reach the limit of their extension, though in all ordinary cases the wheel will start before this limit is reached.

Fig. 6 contains a suggestion for the braking mechanism and Fig. 6-A shows the details of the parts. All these small parts may be cast in "alzinc." For fastening the parts in suitable positions on the frame of the machine, some ⅝-in. studs have been shown on the frame at *a* and *b*, Fig. 1. These are to be brazed in at the time of constructing the frame. The studs, *a* and *b*, support, respectively, the brake pedal and the bell-crank lever. The brake shoe is swung from a journal, *c*, which consists of a piece of ½-in. tube brazed across the reaches. A small spring should also be provided at some point in the system to keep the brake shoe away from the tire when it is not in use. This forms an exceedingly powerful brake, and it should, therefore, be used rather sparingly, so that the tire may not be subjected to any more wear than is absolutely necessary. For the purpose of distributing the wear over the surface of the tire as much as possible the hollow of the brake shoe should be given a curvature of less radius than that of the tire outline, so that it comes in contact with the sides of the tire rather than with the extreme outer surface, which is subjected independently to considerable wear from contact with the road surface. The battery and motor will be described in a succeeding article.

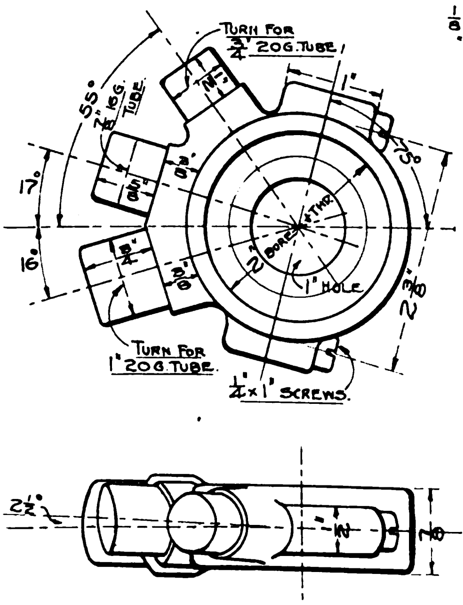

FIG. 5.—CASE FOR REAR AXLE BEARINGS.

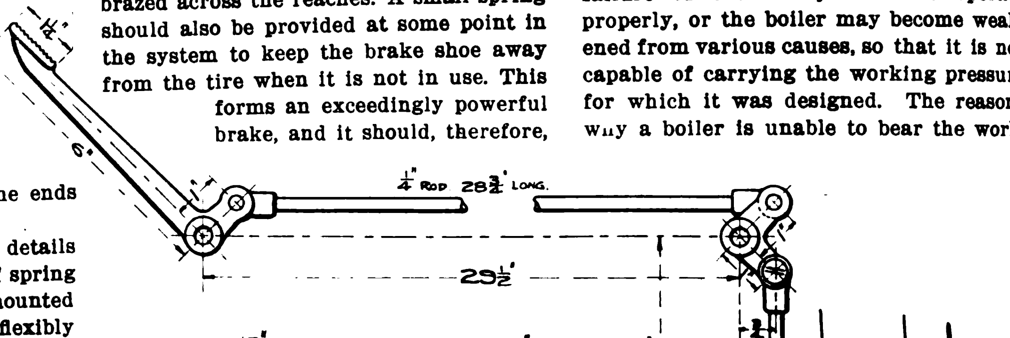

FIG. 6.—BRAKING MECHANISM.

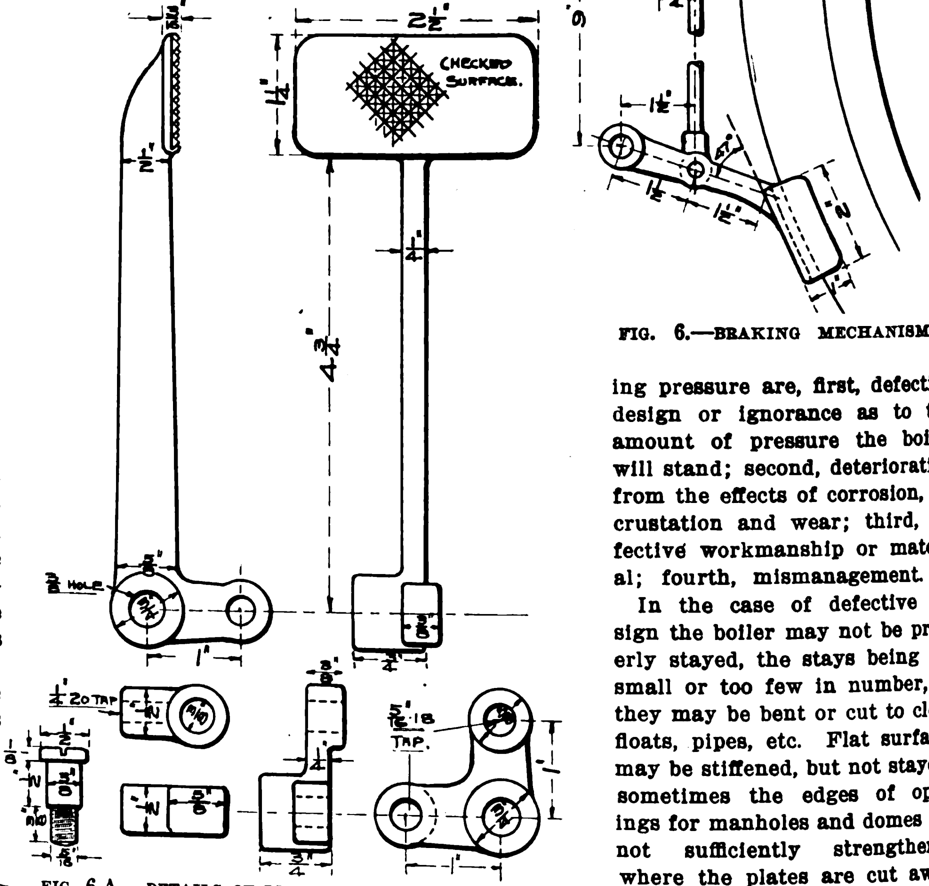

FIG. 6-A.—DETAILS OF BRAKING MECHANISM.

Tower for St. Louis Fair—One of the special features proposed for the St. Louis Fair is a giant tower, consisting chiefly of a globe 350 ft. in diameter, carried on pillars 250 ft. high with an observation tower 100 ft. above the top of the globe. The estimated cost is $1,500,000.

BOILER EXPLOSIONS.

BY CHAS. L. HUBBARD.

The general cause of all boiler explosions is obviously over-pressure of steam. This over-pressure may be caused by the failure of the safety valve to operate properly, or the boiler may become weakened from various causes, so that it is not capable of carrying the working pressure for which it was designed. The reasons why a boiler is unable to bear the working pressure are, first, defective design or ignorance as to the amount of pressure the boiler will stand; second, deterioration from the effects of corrosion, incrustation and wear; third, defective workmanship or material; fourth, mismanagement.

In the case of defective design the boiler may not be properly stayed, the stays being too small or too few in number, or they may be bent or cut to clear floats, pipes, etc. Flat surfaces may be stiffened, but not stayed; sometimes the edges of openings for manholes and domes are not sufficiently strengthened where the plates are cut away. The boiler may be set too rigidly, with no provision for the expansion and contraction of the plates. Defective water circulation will often cause overheating, excessive incrustation, etc., and failure of the feed apparatus to work properly may cause low water, resulting in overheating, rupture and explosion.

The strength of a boiler may be reduced by corrosion, pitting or grooving, or by fractures. Disasters are also caused by external corrosion in many cases. Weakening of the boiler from corrosion of any form is difficult to detect and may proceed unseen for a long time; investigation has often shown the plates of a ruptured boiler to be much reduced in thickness. An explosion may be caused by the formation of a pocket due to incrustation; any sign of difficulty from this cause should be promptly attended to. The admission of cold feed water on hot plates is likely to cause fractures, which will be enlarged by fluctuation of steam pressure and corrosion until the boiler becomes too weak to stand the working pressure. Vertical boilers are more likely to explode than horizontal ones. The upper ends of the tubes passing through the steam space sometimes collapse and the crown sheet, through corrosion, is apt to bulge downward. When a boiler gives way in this manner the reaction of the escaping steam may throw it high in the air.

Overheating makes the plates soft and weak, and a boiler originally strong enough to stand a high pressure may be injured in this way. Overheating may be caused by low water, accumulation of sediment or scale on the furnace plates or flues, or by defective circulation. Low water may be caused by leakage through joints or blow-off cocks and valves, or by neglecting to close these properly after use. It is also caused by a sudden demand for steam, or by the failure of the feed pump or injector to work properly.

Fractures are of two kinds; those caused by insufficient freedom for expansion and contraction and those caused by the inability of the material to bear the steam pressure. In an internally-fired boiler, the internal flue may expand considerably, while the shell, held by the stays and ends, will expand but little. When the fire is external and under one end, the plates just above it being very hot, expand more than the rest of the shell or the tubes. If the tube sheets cannot expand and contract, the tube holes are likely to become oval and leak. Furnace plates sometimes fracture from sudden contraction caused by the cooling of the plates when the furnace door is opened. A plate usually fractures from the holes to the edge of the plate in the outside lap.

Fractures are not always dangerous, but should of course be repaired promptly upon discovery. Usually they are small and at first barely visible, but soon enlarge, and when increased by corrosion cause leakage and perhaps rupture. When the lap edge fractures extend through the rivet holes into the plate, drilling holes and placing rivets in their path will stop them. When the fracture runs in a line between the rivet holes it is very dangerous. A good plate will usually leak and give indications of danger, while a brittle plate gives way suddenly. Thick plates are more likely to fracture than thin ones.

Bad workmanship and brittle plates are the common cause of fractures. Careful supervision and the employment of skilled workmen are the only remedies for this evil. In case a plate is punched at the wrong points and then punched over again, it is greatly weakened. Defects of workmanship are found by examination and by subjecting the boiler to hydrostatic tests. These consist of careless punching and riveting, fractured rivet holes, broken rivets, carelessly secured stays, and fractures in flanging, bending, welding, etc. Patching old plates with new ones is apt to weaken them, especially if the removal of the old rivets and the placing of new ones is not carefully done. The greater contraction and expansion of the new plate causes severe local strains. Defects of workmanship are not easily discovered, and extremely careful inspection is required in order to locate them.

Explosions may occur through mismanagement in different ways. The pressure may rise above the safe limit by the rusting of the safety valve or by intentional or accidental overloading, or by placing a stop valve between the boiler and the safety valve. When the size or lift of the safety valve is small, steam may be generated faster than it can escape, and cause a rapid rise in pressure. The lever safety valve is easily overloaded, either by an increase in length or by the addition of extra weights; or it may be wedged in place. The safety valve is sometimes overloaded to make the blowing-off pressure equal to that indicated by a defective gauge; at other times it may be weighted or wedged to prevent leakage. The sudden opening or closing of a large steam or safety valve may produce a sudden rush of steam and water against some part of the boiler, of sufficient force to cause a rupture and perhaps an explosion. The practice of placing a stop valve between the boiler and the safety valve should never be allowed. During repairs the stop valve may be closed, and neglect to open the valve on restoring steam pressure is likely to cause serious trouble.

The position of a fracture has a great influence on the results. In case a large rent occurs at the top of a cylindrical boiler the steam and water may blow out of the hole and the boiler, if strongly set, may remain in place. If, on the other hand, the rent were to occur on the under side of the boiler near the ground or floor the effect would be very different, and the reaction of the escaping steam would probably blow the whole boiler through the roof.

When an explosion occurs it should be promptly investigated, both to fix the responsibility as far as possible and to learn how to provide against future disasters. Low water is often given as a reason for explosion, since it is an easy way to throw the responsibility from the makers or owners on those directly in charge. In the investigation of an explosion the weights, shapes, positions and directions of the scattered pieces should be noted, so that their original places may be known. The original size and shape of the boiler and of the fittings should be known as accurately as possible. The primary rent may be discovered from a comparison of the directions taken by the heavier pieces. The smaller fragments will generally take the direction of the escaping steam, while the heavier parts take an opposite direction, that of reaction. A careful examination of the pieces, noting the age of fractures, thickness of plates, amount of corrosion, etc., will generally show the cause. A test of the plates will, in many cases, show any softening or yielding to the pressure and excessive thinness caused by bulging.

The means taken to prevent boiler explosions are quite plainly indicated by what has already been said. It is of first importance that only well-designed and well-made boilers be used. The type of boiler is not of so much importance, but as a special safeguard it may be better to use sectional or water-tube boilers in large cities or in buildings where many people are employed. Accidents from mismanagement may be greatly lessened by the employment of licensed attendants. A boiler should never be in the hands of a man who is not positively known to be competent to run it. The most effective method of preventing explosions is the state law compelling regular and thorough inspection and licensed firemen. Inspection by the boiler insurance companies is also an efficient method.

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THE SELECTION OF LUBRICATING OIL.

Oil intended to lubricate bearings, slides and other rubbing surfaces should be invariably pure mineral oil, devoid of any vegetable or animal fat. Vegetable oils have no lubricating properties whatever, and oxidize at a comparatively low temperature, becoming thick and gummy; animal oils also thicken and become sticky and gummy when exposed to the influence of the atmosphere and the warmth of rubbing surfaces. Animal and vegetable oils are often compounded with a mineral oil in order to produce an engine oil having high viscosity and fire test; such a compound should never be accepted at any price. In order to test engine oil for "loading," put a little caustic soda or soda ash solution in the oil and shake it up. If it clouds up and looks soapy this is an indication of animal oil.

Paraffine is also highly objectionable. A convenient test for paraffine is to put a bottle of the engine oil on ice for fifteen or twenty minutes; if the oil becomes cloudy, it is loaded with paraffine and should be rejected without further argument or investigation. Engine oils having an opalescent green tinge when held up to the sunlight instead of appearing clear yellow or red, are adulterated with either kerosene or some lighter hydro-carbon, which is not a lubricant and which volatilizes as soon as it is warmed by the friction of the bearings. Any engine oil, therefore, which has the slightest tinge of opalescent green should be rejected. Engine oils for high speed should show a viscosity of at least 170 and should range from that point up to 195 at an ordinary temperature, say 75°. The oil should have a specific gravity of about 30; it should not be under 29 nor over 31. The flash test should be between 400° and 440° Fahr.

Cylinder oils for use in connection with a cylinder where the steam pressure is less than 100 lbs. per square inch should show a fire test not less than 590° nor more than 630°. For pressure over 100 lbs. and up to 200 the viscosity should be from 640° to 660°. The specific gravity of a cylinder oil showing a fire test of 600° should be from 26 to 27, and for a fire test of 660° the specific gravity should be about 24 to 25. Unless there is considerable moisture in the cylinders, cylinder oil should not contain any animal oil, and vegetable oil should not be used under any consideration. If animal oil should be necessary, acidless and refined tallow oil should invariably be used. For steam pressures of 100 lbs. or less, 8 to 10 per cent of tallow oil may be compounded with mineral cylinder oil, and for pressures of 100 to 200 lbs., 3 to 6 per cent may be used. Common lump tallow should never be used for compounding, as it contains acid which attacks the metal of the cylinder walls and leaves charred particles in the steam.

An adulteration commonly found in cheap grades of cylinder oil is wool fat, which is used to cut the gummy ingredient and give the oil a good flow in a cold test. Wool fat causes separation and a thick deposit in the bottom of the barrels, and results in the same charred deposit in the cylinder as lump tallow.

INTERIOR WIRING.

WIRING TERMS AND THE MEASUREMENT OF FEEDERS AND MAINS.

The various members of a complex wiring installation are designated feeders, sub-feeders, mains, branches, and taps. A "feeder" is a stretch of wiring to which no connection is made except at its two ends; a sub-feeder is of the same class, but is distinguished from a feeder either by being one of two or more connecting links between the end of a single feeder and several "distributing mains," or by constituting an extension of a feeder. A "main" is a stretch of wiring supplied from one or more feeders or sub-feeders and distributing current to a number of "taps," or else to a number of "branches." A "branch" distributes current among a number of lamps, etc., while a "tap" almost invariably delivers current to a single lamp or other device. Reference to Fig. 1 will make these definitions clearer. It is scarcely necessary to state that this diagram is merely intended to illustrate the above definitions and by no means represents any rational plan of wiring.

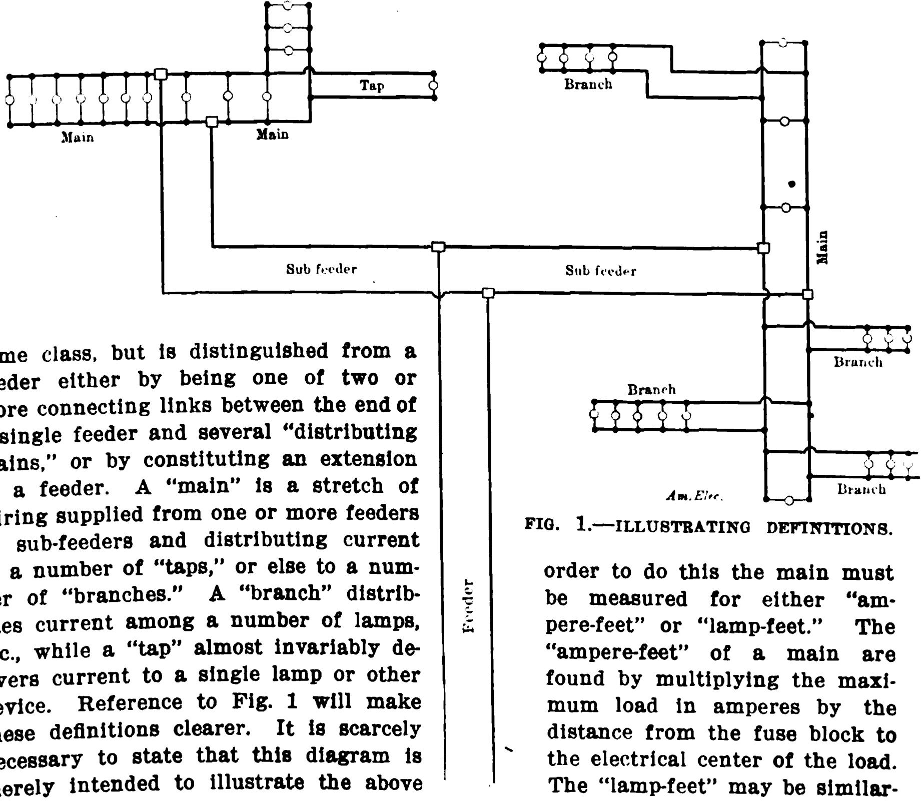


FIG. 1.—ILLUSTRATING DEFINITIONS.

The simplest possible wiring installation, as indicated in a previous article, is one in which a single lamp or compact cluster of lamps is located at the end of a main, as shown in Figs. 2 and 3 herewith. In such cases calculations are almost always unnecessary, for the reason that No. 14 wire, the smallest size allowed by the Underwriters, will supply several lamps at a long distance (as interior wiring goes) with a very moderate drop. For example, if the three lamps shown at the end of the main in Fig. 3 were of 16 candle-power each, and the e.m.f. of the supply circuit 110 volts, a main of No. 14 wire would supply the lamps at a distance of 135 ft. from the fuse block with a drop of only 1 per cent. When the lamps are strung along the main, however, as in Fig. 4, it is sometimes necessary to choose the size of wire with regard to the drop, and in order to do this the main must be measured for either "ampere-feet" or "lamp-feet." The "ampere-feet" of a main are found by multiplying the maximum load in amperes by the distance from the fuse block to the electrical center of the load.

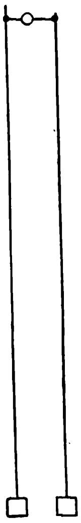


FIG. 2.

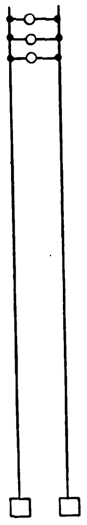


FIG. 3.

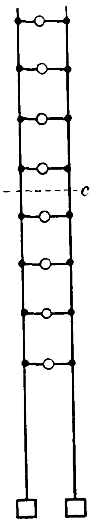


FIG. 4.

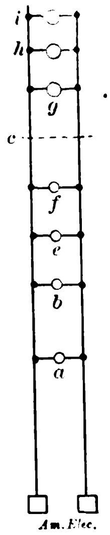


FIG. 5.

The "lamp-feet" may be similarly found by multiplying the total number of lamps by the distance from the fuse block to the electrical center of the group.

The location of the electrical center of distribution depends upon the spacing of the lamps and whether or not they are all of the same size. If they are of uniform capacity, and spaced at equal distances, the center of distribution will be identical with the geometrical center of the string of lamps, as indicated by the dotted line, *c*, in Fig. 4. If, however, the lamps are of different sizes, and spaced irregularly, as in Fig. 5, the electrical center does not coincide with the geometrical center unless the lamps happen to be symmetrically distributed as to differences in sizes and distances apart. Although such an irregular arrangement as that indicated in Fig. 5 would rarely be met in practice, it is just as well to understand the principle of locating the center of distribution for such a group. This can be done by reducing the large lamps to the basis of the smaller ones and then ascertaining the electrical center.

For example, if the three large lamps, *g*, *h*, *i*, were of 32 candle-power each and the others of 16 candle-power, the large lamps would be considered as three *pairs* of 16-c.p. lamps. The center of distribution could be found by adding together the lamp-feet of every section of the main and dividing the result by the number of 16-c.p. units.

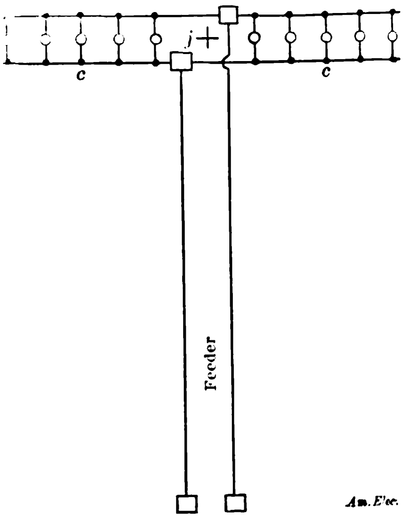


FIG. 6.—SYMMETRICAL DISTRIBUTION.

Thus, suppose the distance from the fuse-block to the lamp *a* were 15 ft. On this scale the distance from *a* to *b* would be 7½ ft.; from *b* to *e* and from *e* to *f*, 5 ft. each; from *f* to *g*, 10 ft.; between *g* and *h*, 3¾ ft., and the same between *h* and *i*. The lamp-feet from the fuse-block to *a* would be 10 lamps × 15 feet = 150 lamp-feet; between *a* and *b*, 9 lamps × 7½ ft. = 67½ lamp-feet; *b* to *e*, 8 lamps × 5 ft. = 40 lamp-feet; *e* to *f*, 7 lamps × 5 ft. = 35 lamp-feet; *f* to *g*, 6 lamps × 10 ft. = 60 lamp-feet; *g* to *h*, 4 lamps × 3¾ ft. = 15 lamp-feet; *h* to *i*, 2 lamps (1 32-c.p.) × 3¾ ft. = 7½ lamp-feet. The sum of these is obviously 375 lamp-feet, and dividing this by 10, the 16-c.p. equivalent of the group of lamps, gives 37½ ft. as the distance from the fuse-block to the center of distribution. This is indicated by the dotted line, *c*.

and happens to come midway between the 16-c.p. and the 32-c.p. lamps. That it does so is purely accidental; if the lamp, *a*, had been of 32 candle-power, the center, *c*, would have been located nearer *f* than *g*.

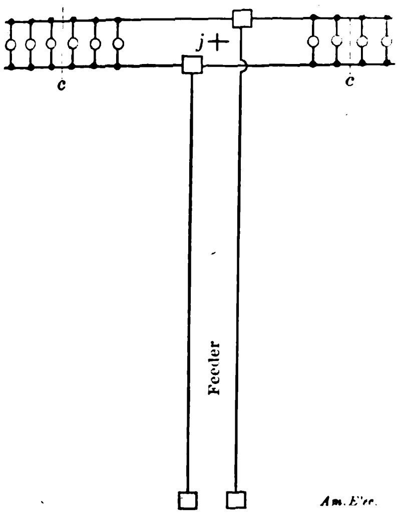


FIG. 7.—UNSYMMETRICAL DISTRIBUTION.

When a main is supplied by a feeder, the junction of the two, if practicable, is located at the electrical center of the main, as indicated in Fig. 6, so that the distribution is symmetrical, *i. e.*, the ampere-feet each way from the junction are the same. This is nearly always practicable in surface wiring, and when it is practiced it is only necessary to calculate the wire size for one-half of the main, as the other half is identical. In the case represented by Fig. 6 there are five lamps on each side of the junction, *j*; the center of each group is the lamp, *c*, so that the lamp-feet in each half of the main are $5 \times d'$, d' being the distance from *j* to *c*. The lamp-feet of the feeder would be $10 \times d$, d being the distance from the feeder fuse-block to the junction, *j*. For example, on a scale of 16 ft. to the inch for the wire-lengths, the lamps in Fig. 6 would be 3 ft apart, the length of the feeder would be 38 ft., and the distance from *j* to *c* 10 ft. The feeder would then have $10 \times 38 = 380$ lamp-feet, and each half of the main would have $5 \times 10 = 50$ average lamp-feet.

In concealed work, however, it does not always happen that a feeder can be made to join a main at its electrical center; when this is not practicable, each end of the main should be figured separately. In Fig. 7, for instance, the main has six lamps on one end and four on the other, and the distances from the junction to the centers of the two groups are also unequal. On the same scale as before, the center of the left-hand group would be 13 ft. from the junction, *j*, giving that end of the main $6 \times 13 = 78$ lamp-feet; while the center of the right-hand group is 11 ft. from *j*, giving that end of the main $4 \times 11 = 44$ lamp-feet. It is obvious that what appears to be one continuous main in this case would have to be treated as two mains, and each part figured separately. The wire to the left of the junction, *j*, would need to be approximately twice the size of that on the right-hand side in order to have nearly the same drop in both directions, and this latter requirement is imperative.

Fig. 8 illustrates an actual case where the unsymmetrical division of mains, while not absolutely compulsory, was preferable on account of surrounding conditions. The distribution adopted was necessary because it was required that all the lamps shown connected to the main, *m*, should be lighted and extinguished by one switch, and the remainder controlled independently by another switch. (The switches and switch wires are not shown in the diagram, being unnecessary to the present discussion.) The feeder was connected to a point as near as possible to the electrical center of the main, *m*, and the sub-feeder was carried straight over to the main, *n*, instead of to its electrical center, in order to avoid carrying it along a tortuous route through a maze of countershafts and belts. In a case of this sort the main is measured each way from the feeder junction, just as though each part of it were entirely separate from the other part.

In considering relatively subordinate branches of a main, such as *a*, Fig. 8, it will usually be sufficient to make the branch of the same size wire as the main, and not take the trouble to calculate it separately. Thus, in measuring the main, *m*, below the feeder junction, *j*, the four lamps in the branch, *a*, would be considered as though they were in a cluster right on the main at the point where the branch joins the main. Having found the size of wire for the main under this condition, the same size would be used for the branch. If the lamp-feet of the branch were insignificant, however, compared with the lamp-feet of that part of the main beyond the branch junction, it might prove practicable to use a size of wire for the branch that would make the drop in it negligible and still be much smaller than the main wire.

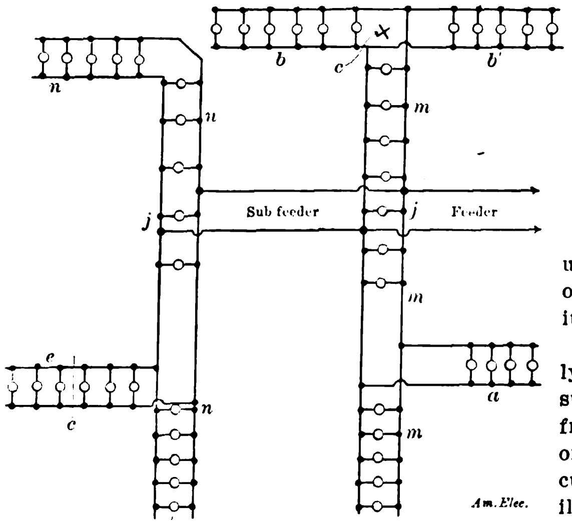


FIG. 8.—UNSYMMETRICAL DIVISION OF MAINS.

In the case of a relatively heavy branch, such as *e*, it is usually necessary to calculate the size of the wire. When there is but the one branch from the main, and it is heavier than that part of the main beyond its junction, as in the case of *e*, it will suffice to consider the branch as a part of the main, and the extension of the main as an inferior branch. Thus, in measuring that part of the main, *n*, which runs from the feeder junction, *j*, downward on the diagram, the distance from *j* to *c* would be taken, *c* being the center of the distribution. The wire for the lower end of the main, *n*, would be made the same size as that in the branch and the main between the branch and the feeder junction, unless the lamp-feet below the branch junction were insignificant and the main wire rather large.

When a double branch, such as *b b'*, is encountered, it will usually suffice to measure the lamp-feet of the main and the heavier of the two branch arms, just as though the lighter arm did not exist; its lamps being considered as though they were all huddled in a cluster at the branch junction; then use the one size of wire throughout. In the case here represented, the lamps on the main, *m*, above the feeder junction, *j*, were 6 ft. apart, and those in the left-hand branch, *b*, were 4 ft. apart. Ignoring the lamp right at the junction, *j*, the main carries 15 lamps, and was figured as though the distribution had been as shown in Fig. 8-A. The total lamp-feet were $3 \times 15 + 3 \times 14 + 3 \times 13 + 3 \times 12 + 3 \times 11 + 3 \times 6 + 2 \times 5 + 2 \times 4 + 2 \times 3 + 2 \times 2 + 2 = 243$ lamp-feet, and the electrical center was therefore $243 \div 15 = 16.2$ ft. from the feeder junction, *j*, or right at the branch junction, as indicated by the cross mark, *c*.

The lamp-feet of the upper end of the main, *n*, are calculated in the same way as explained in the case of Fig. 5, and the lamp-feet of the sub-feeder are, of course, found by multiplying the total number of lamps connected to the main, *n* (21), by the distance across from *m* to *n*. The feeder is not shown complete; its measurements is like that of any other feeder; the product of its length and load.

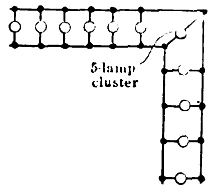


FIG. 8-A.

In conduit work it is nearly always the case that every sub-feeder or main radiating from a common tablet board or junction box must be calculated individually. Fig. 9 illustrates a possible case in which both symmetrical and unsymmetrical distribution occur. The circles here represent outlets, and the figures at each outlet indicate the number of lamps supplied therefrom. The sub-feeders and mains are represented by single lines, as is customary in modern wiring diagrams. The two 15-lamp outlets are located at equal distances from the distributing pocket or cabinet, *P*, so that the sub-feeders, *a* and *a′*, have equal values of lamp-feet. The sub-feeders, *b*, *b′*, have equal lengths, but as one supplies 10 lamps, and the other 16, the lamp-feet are different, and each sub-feeder would have to be figured separately. The main (so-called in order to avoid the use of the term sub-feeder or some equivalent, and not because it does any "distributing"), *g*, in such a case, should be considered as a part of the sub-feeder, *b*, in order to avoid the necessity for a fuse at the junction of the two. As it is symmetrically divided, only one-half of it would be considered. Thus, if the sub-feeder, *b*, were 42 ft. long, and the main, *g*, 24 ft. long, from outlet to outlet, the sub-feeder would have 16 × 24 = 672 lamp-feet and one-half of the main would have 8 × 12 = 96 lamp-feet. The proper course would be to take 672 + 96 = 768 lamp-feet as the load-length from the panel board, *P*, to the two 8-lamp outlets, and use the proper size of wire for that figure, making the sub-feeder, *b*, of the same size as the main, *g*. The same procedure applies to the sub-feeder, *b′* and main *g′*; also to the sub-feeder, *e*, and the main, *f*.

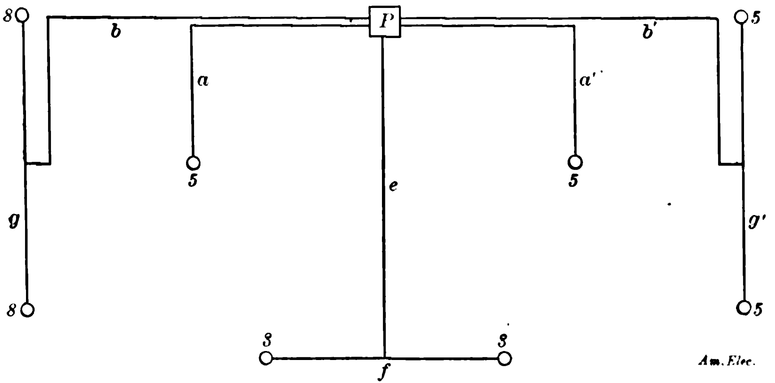


FIG. 9.—EXAMPLE OF SYMMETRICAL AND UNSYMMETRICAL DISTRIBUTION.

It will doubtless help the reader to a better grasp of the principle to assume distances and drop, and work out the whole installation shown in Fig. 9. Suppose then, that the voltage is 110, the allowable drop in the part of the wiring here shown, ¾ of 1 per cent, and the lengths and load-lengths of the various sub-feeders and mains as below:

TABLE I.

For 110-volt incandescent wiring. Numbers in body of table are Lamp-Feet. Table computed for 3½-watt 16-c.p. lamps.

Wire Sizes.	Drop in percentage of the rated voltage.										
	½	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3
0000	10,815	16,220	21,630	27,040	32,445	37,855	43,265	48,670	54,080	59,485	64,890
000	8,575	12,865	17,155	21,445	25,730	30,020	34,310	38,600	42,890	47,175	51,460
00	6,800	10,200	13,605	17,000	20,400	23,810	27,210	30,620	34,010	37,415	40,810
0	5,395	8,095	10,795	13,490	16,190	18,890	21,590	24,290	26,985	29,685	32,385
1	4,275	6,415	8,555	10,695	12,830	14,975	17,110	19,250	21,390	23,530	25,670
2	3,390	5,085	6,785	8,480	10,175	11,875	13,570	15,265	16,965	18,660	20,355
3	2,690	4,035	5,380	6,725	8,070	9,415	10,760	12,105	13,450	14,795	16,140
4	2,130	3,200	4,265	6,335	6,400	9,470	8,535	9,600	10,670	11,735	12,800
5	1,690	2,535	3,380	4,230	5,075	5,920	6,765	7,615	8,460	9,305	10,150
6	1,340	2,010	2,680	3,555	4,025	4,695	5,365	6,035	6,705	7,380	8,050
7	1,060	1,595	2,125	2,655	3,190	3,720	4,255	4,785	5,315	5,850	6,380
8	840	1,265	1,685	2,110	2,530	2,955	3,375	3,795	4,220	4,640	5,065
9	665	1,000	1,335	1,670	2,005	2,340	2,675	3,010	3,345	3,680	4,015
10	530	795	1,060	1,325	1,595	1,855	2,120	2,385	2,650	2,915	3,180
10 & 12	432	697	864	1,080	1,295	1,510	1,725	1,945	2,160	2,375	2,590
12	333	500	667	834	1,000	1,168	1,335	1,500	1,665	1,835	2,000
12 & 14	271	407	543	679	815	950	1,085	1,220	1,355	1,495	1,630
14	209	314	418	629	629	734	839	944	1,045	1,155	1,255

Sub-feeder or main.	Length, in feet.	Lamp-feet.
a and *a*	28	420
b	42	672
b′	42	420
g	24	96
g′	24	60
e	28	168
f	10	15

Then the combined lamp-feet of each related sub-feeder and main would be:

b and $g = 768$;
b' and $g' = 480$;
e and $f = 183$.

Table I, herewith, gives the lamp-feet for the standard sizes of wire at various drops in percentage of 110 volts. It shows that the following sizes of wire would be required to keep the drop within ¾ of 1 per cent in the sub-feeders *a* and *a′*, and each of the combined sub-feeders and mains shown:

	Lamp-feet.	Wire size.
a or *a′*, each,	420	No. 12
b and *g* combined,	768	No. 10
b′ and *g′* "	480	No. 12
e and *f* "	183	No. 14

The principal feeder (not shown), terminating at the pocket, *P*, would have 62 × *d* lamp-feet, *d* being the distance from the feeder fuse-block to the pocket, *P*, as the feeder runs, and 62 being the total number of lamps supplied from the pocket.

It will be evident from the foregoing that the length of any feeder or main is the one-way distance, *i.e.*, the length of one wire. This is true regardless of the number of wires in a feeder or main. Of course, the size of wire is not the same for a three-wire feeder as for a two-wire feeder of the same length, load, lamp voltage and drop, but this is taken into consideration in the formulas and tables for drop, and has no bearing upon the measurement of the length or the lamp-feet (or ampere-feet, as the case may be) of a feeder or main. The determination of wire sizes and division of the total drop between the various "members" of a wiring installation will be discussed in a future article.

AMERICAN METER PRACTICE.

BY LYMAN C. REED.

MEASURING POWER IN ALTERNATING-CURRENT CIRCUITS.

A non-inductive meter can be used for either direct or alternating current. A familiar type is the Thomson recording wattmeter. In this type of meter the field coils are in series with the current flowing, the shunt field coils are energized proportionately to the voltage of the circuit, and the torque exerted on the armature is for any instant proportional to the product of the instantaneous values of the current and e.m.f., hence the mean torque is proportional to the product of effective volts by effective amperes, or the effective watts passing in the circuit.

The method of connecting this meter on a simple alternating-current circuit is the same as on direct-current circuits, and in fact it is interchangeable without recalibration, the error being for practical purposes inappreciable. The induction form of wattmeter is operated by means of a "shifting" field acting on a closed secondary armature, the eddy currents induced in the armature reacting on the shifting or rotating field in such a manner as to produce a torque proportional to the power passing. In this type of wattmeter, of which there are many forms, the series and shunt field coils are wound in inductive relation to a movable closed secondary or armature in which eddy currents are induced proportional to the magnetizations set up in the series and shunt field coils. The current in the shunt field coils is displaced in phase from that in the series coils by having a reactance placed in series with the shunt coils, and the magnetizations produce a resultant field that shifts around the common axis.

The field set up by the induced eddy currents in the revolving secondary lags behind the resultant field set up by the series and shunt field coils, creating a torque on the secondary which is proportional to the square of the energy flowing. The providing of a brake whose retarding force varies as the square of the speed enables the power passing to be indicated by the speed of the revolving spindle to which the armature is attached. There are many variations and different arrangements, all based on the foregoing general principles.

The power passing in an alternating-current circuit at any instant is equal to the product of the instantaneous values of the current and the e.m.f., but ordinary measuring instruments do not measure instantaneous values, but show what are termed "mean-effective" values. When the current in an alternating circuit is in phase with the e.m.f., the effective power is equal to the product of the effective current and effective e.m.f., and under this condition a wattmeter on a single-phase circuit will give an indication equal to the product of the indications of a voltmeter and an ammeter in the same circuit, assuming, of course, that all three instruments are accurate.

When the current lags behind the e.m.f., however, it attains its maximum value after the e.m.f. has passed the point of maximum strength and is decreasing, so that the combined effect of the current and e.m.f. is less than when the two are in phase, *i. e.*, when they attain their maximum values at the same instant. The resultant torque, therefore, exerted on the coils of a wattmeter in circuit with an inductive load (which always produces a lag in the current) is not proportional to the product of the effective volts and effective amperes as measured by separate indicating instruments, but to this product multiplied by the "power factor" of the circuit. The power factor is the ratio between the "true" and "apparent" watts; the product of voltmeter and ammeter readings gives the apparent watts, therefore, while the wattmeter shows the true watts. In the metering of three-wire single-phase systems, inductive or non-inductive, the same general principles outlined in the foregoing hold true.

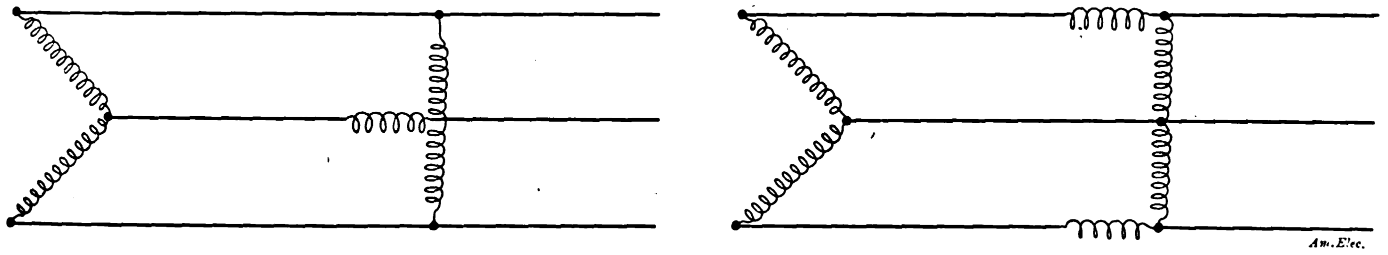


FIG. 1.—MEASURING POWER ON BALANCED CIRCUITS FEEDING INDUCTIVE LOADS.—FIG. 2.

The quarter-phase system, employing four wires for its distribution, is metered exactly as two separate single-phase circuits would be, the total power in the two phases being the sum of the power components of each phase. When the two phases are balanced, that is, have the same amount of power passing in each phase, it is only necessary to meter one phase and multiply the result by two to get the total amount of energy passing. When the phases are unbalanced, that is, have different loads on each phase, two meters are necessary, one in each phase, to register the energy passing.

When three wires are used in the distribution of two-phase currents, one wire acts as a common return for the other two and the instantaneous value of the current on the common return at any instant is the algebraic sum of the instantaneous values of the currents of each phase. The algebraic sum of these two currents, if they have the same value, is $\sqrt{2} \times$ the value of either one of them. Similarly, the resultant voltage measured across from outside to outside of the three-wire system is $\sqrt{2} \times$ the voltage from the common-return wire to either of the outer wires; the total power in the system is the product of the resultant voltage across the outer wires and the resultant current in the common-return wire. Thus, if the current in each outside wire be represented by I, the voltage from the middle wire to the outside wire be represented by E, the return wire will be equal to $\sqrt{2} \times I$, and the voltage across from outside to outside will be equal to $\sqrt{2} \times E$. The total effective power will, therefore, be $\sqrt{2} \times E \times \sqrt{2} \times I$, which simplifies to $2 \times E \times I$, and corresponds with the statement in the preceding paragraph.

The resultant e.m.f. and resultant current being in phase with each other when the load is balanced, a meter with its series field coils placed in the common return, and its shunt field coils energized by the resultant voltage of the system, as in Fig. 1, would give the true power passing in the circuit. When the load is unbalanced, the resultant current in the middle wire leads or lags behind the resultant voltage of the system and may be displaced in phase either way by 45 degrees on non-inductive load. The true power in the circuit is then obtained by multiplying by the cosine of the angle of lag or lead. As a wattmeter records the product of the effective values with respect to their relative instantaneous values, and not the maximum values of current and voltage, the record is a true one of the power passing in the circuit.

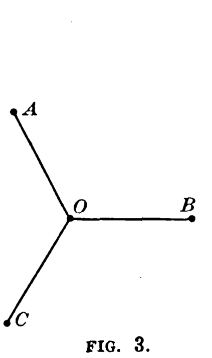


FIG. 3.

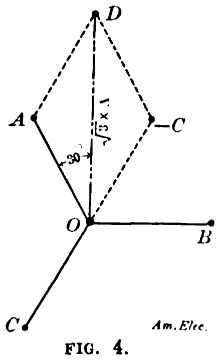


FIG. 4.

This connection, Fig. 1, however, will not give a record of the true power passing on an *unbalanced inductive* circuit, as an angle of lag or lead of 45 degrees could give a wattless register, allowing 70 per cent of the passing power to remain unrecorded. On *balanced* circuits, however, feeding an inductive load, this connection serves just as well as when two meters are used, as shown in Fig. 2, where the series field coils are connected in the outside legs of the circuit and the potential circuit fed between the given leg in the meter and the common return. When the induction type of meter is used, the potential circuit is so connected as to differ in phase from the series field circuit by 90 degrees, hence in Fig. 2, the potential circuit for each meter would be fed from the given leg in the meter to the other outside wire. This is the connection most commonly used in metering two-phase circuits.

The elements of two meters are often combined under one cover to act on a common armature. The elements are connected in the same manner as though they were separate meters and need not be further elaborated.

Three-phase circuits are connected in "star" or "delta" grouping; the former sometimes uses four wires in the distribution, while the latter is always distributed by means of three wires. In Fig. 3 the star grouping with common center at "O" is shown, the voltage of the three legs being represented in intensity and phase by the lines A, B, C. The resultant voltage of such a system for any instant of time may be found graphically by producing the single leg of opposite sign to the other two, backward, and finding the resultant by the parallelogram of forces. The diagonal will represent in sign and phase the resultant of the voltage on the three legs.

In Fig. 4 the resultant is $\sqrt{3}$ times the voltage of one phase and leads it by 30 degrees. If one phase is selected as the basic one, the resultant voltage will be found to be always leading it by 30 degrees. In a balanced circuit, connected as in Fig. 4 the current will have a resultant coinciding with the voltage resultant, and the product of the two resultants will, for a non-inductive load, represent the true power passing. The algebraic sum of the resultants of the voltage taken consecutively between the three legs of a system will equal for any instant the resultant positive or negative value of the voltage at that instant. Likewise, the resultant of the current flowing for any instant is the algebraic sum of the three resultant currents of the system found in like manner. Therefore, the current passing over any two legs of a three-wire three-phase circuit is the algebraic sum of the three resultant currents of the system; hence the power passing in the circuit is the algebraic product of the resultant current and voltage.

Some simple rules deduced from the above may be of service in rapidly computing the energy passing in polyphase systems. In star or "Y" connected systems, or any system employing a common neutral, the resultant voltage is equal to the effective voltage × $\sqrt{m}$, m being the number of phases. The resultant current flowing in any system is the average of the sum of the currents × $\sqrt{m}$. The energy passing is therefore the common resultant voltage × common resultant amperage × cos. ϕ or lag angle.

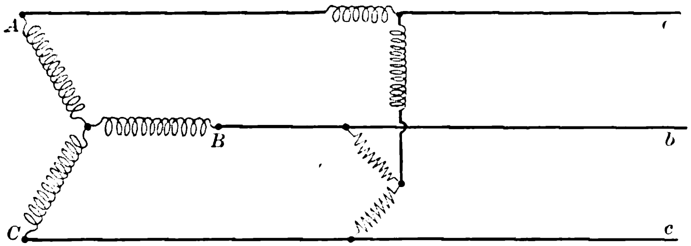


FIG. 5.—CONNECTION FOR NON-INDUCTIVE TYPE OF METER.

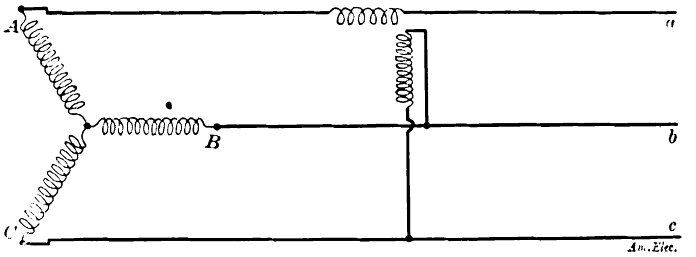


FIG. 6.—CONNECTION FOR INDUCTIVE TYPE OF METER.

Suppose, for example, the amperes in the different lags of a three-phase unbalanced system are 10, 20 and 30 respectively, and the effective e.m.f. of the circuit, taken with regard to a common neutral point or conductor, is 100 volts. The average value of the current is 20, and the resultant is 20 × $\sqrt{3}$ = 34.6 amperes. The resultant voltage is 100 × $\sqrt{3}$ = 173.2 volts. The cosine of angle of lag, ϕ, is taken as 0.5, corresponding to an angle of 60 degrees. The energy passing in such a circuit is 34.6 amperes × 173.2 volts × .5 = 3000 watts. The same result is obtained by taking each leg separately, multiplying amperes × effective volts × cos. ϕ; thus, 60 amperes × 100 volts × .5 = 3000 watts. The common neutral point or conductor is not always available, hence the advantage of the first method, where in practice the resultant voltage is the voltage between any two lines.

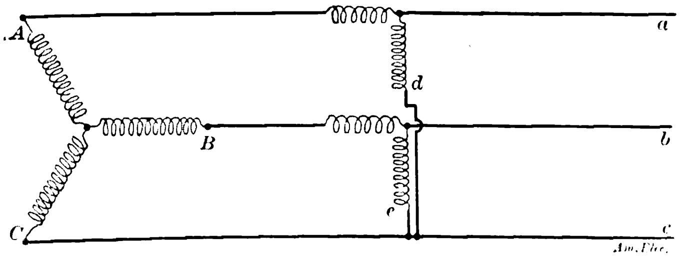


FIG. 7.—NON-INDUCTIVE METERS MEASURING UNBALANCED LOAD.

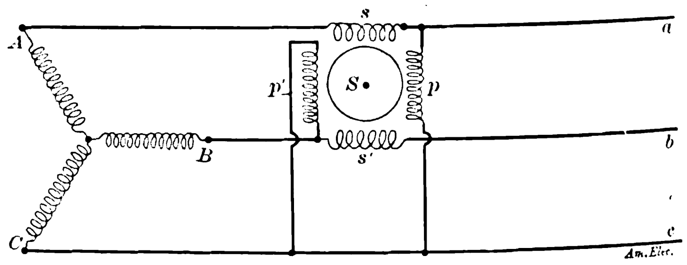


FIG. 8.—COMPOSITE INDUCTIVE METERMEASURING UNBALANCED LOAD.

Where the current lags a different amount in the different branches of the circuit, the resultant amperes may be plotted graphically, or the power of each leg may be computed by multiplying the apparent watts by the power factor, and adding the amounts thus obtained to get the total energy of the circuit. When the neutral point of a star-connected system is extended to the distribution, the system becomes three independent circuits with a common neutral, the algebraic sum of the currents in the neutral for any instant being zero.

The power in a three-phase circuit may be measured by one, two or three wattmeters, or their equivalent, of either the inductive or non-inductive type. The non-inductive type of meter has maximum torque when the shunt field coils and series field coils are in phase; therefore, as the lag angle increases the torque diminishes until at quarter phase the torque is zero. Hence it is impossible in meters of this character to combine series fields of different phases to act in conjunction with shunt field coils in phase with only one of them to measure the energy passing. The case where only one meter is used to measure unbalanced polyphase power factors is confined to meters of the inductive type, where one or more measuring elements are combined to give a resultant measuring value to a common movable armature.

In Fig. 5 let *A B C* represent a three-phase source feeding a circuit having a balanced load. The series coil of the meter is then placed in either one of the three circuit legs and the shunt field coil fed by the effective voltage of the system obtained from a star-connected set of resistances having a common neutral point. This connection applies to either star or mesh groupings. The register of the meter is then multiplied by three to obtain the total power of the circuit. That is, the power passing in each leg of the circuit is:

$$P = \frac{3\ EI}{\sqrt{3}} = \sqrt{3}\ E\ I.$$

In this instance Fig. 5 represents the connection for a non-inductive type of meter. If an inductive meter is used, the series and shunt field coils must be displaced 90 degrees in phase, and the meter fed as shown in Fig. 6, wherein the potential circuit is fed between c and b, whose resultant voltage lags 90 degrees behind the current in a. One meter is sufficiently accurate for balanced three-phase loads, but when the load becomes unbalanced, two legs of the circuit must be metered.

If non-inductive meters are employed they are connected as shown in Fig. 7, where the current in a lags on non-inductive load 30 degrees behind the voltage in the shunt coil d, likewise current in b lags 30 degrees behind the voltage in e. The sum of the two registers of the meter is equal to the resultant voltage of the system multiplied by the resultant amperes. If the current is inductive, the current in a lags cos. $(\phi + 30)$ degrees behind the voltage, likewise current in b lags cos. $(\phi - 30)$ degrees behind the voltage in e. In other words, the true watts equal the resultant current × resultant voltage × cos. ϕ. The power passing is equal to the algebraic sum of the two registers. It is easily seen that when $\phi = 60$ degrees the expression cos. $(\phi + 30)$ is equal to cosine 90 degrees, which gives a wattless register. Under such conditions one meter registers the total current. If the lag angle is greater than 60 degrees one meter runs backward.

Instead of the two meters just shown in Fig. 7, one inductive meter may be used, which in general consists of two elements combined under one cover; in short, two single-phase meters so arranged with regard to a common armature that the power passing is recorded on a single dial train. There are many forms of this meter, but in principle they bear sufficient resemblance to the one shown diagrammatically in Fig. 8 for it to represent them.' Here, *A* is a closed secondary or armature in inductive relation to the series and shunt field coils *p p,' s s'*, which are displayed in phase by 90 degrees. The maximum torque is therefore exerted when the phase displacement is 90 degrees, and diminishes as the angle decreases, becoming zero when the two circuits are in phase. This is the condition of the circuit having a lag of 90 degrees or wattless current. This action is just the opposite of the action in the non-inductive meter, where the torque diminishes as the series and shunt field coils become displaced in phase. The torque of both meters varies, however, with the cosine law, but in opposite directions. Delta-connected systems are metered in the same manner, in fact, the three-wire, two-phase "Y," and delta-connected three-phase systems are all metered alike.

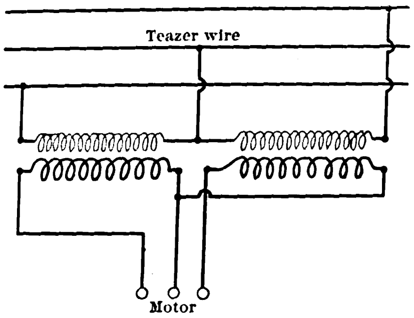


FIG. 9.—MEASURING POWER IN A MONOCYCLIC CIRCUIT.

The metering of such systems as the monocyclic is worked out along the same general lines, but presents some peculiarities which are interesting. In the monocyclic system a regular single-phase circuit is used in conjunction with a third wire called the teaser, which differs from the single-phase circuit by 90 degrees in phase. In the generator one end of the teaser coil is tapped on to the middle of the single-phase coil, and the other end leads to a collecting ring. Such a system is adapted to the distribution of light and power, the lights being connected to the single phase in the usual way, and the motors as illustrated in Fig. 9.

The primaries of the two transformers are placed in series with the teaser connected to the point of joining. The secondaries are cross-connected, forming a resultant lop-sided three-phase relation, which is used to operate a three-phase motor in the same manner that a regular three-phase system would do.

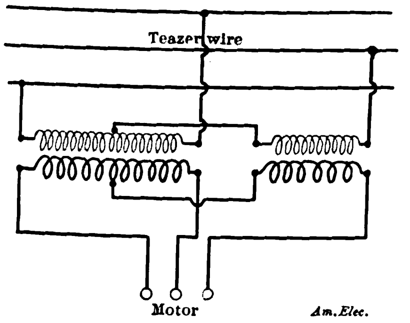


FIG. 10.—MEASURING POWER IN A MONOCYCLIC CIRCUIT.

Another way of connecting up two transformers to accomplish the same results is illustrated in Fig. 10, wherein a small transformer is shown connected between the teaser and the middle point of the large transformer, the relation of the current in the secondaries then being the same as in the generator.

To meter the power passing in the circuit connected as in Fig. 9, one proceeds exactly as in the case of an unbalanced three-phase system, or a two-phase system employing a common return. Hence, with non-inductive meters one is connected in each outside leg and the potential circuit is connected between the given leg and the common return. With inductive meters the regular polyphase meter used for three-phase and two-phase systems is placed in circuit. As has been pointed out, this meter usually consists of two elements combined under one cover and acting on a common armature.

Lessons in Practical Electricity

RESIDUAL MAGNETISM—HYSTERESIS.

When a piece of iron or steel has been magnetized by a current traversing a coil, as explained in previous Lessons, and the "exciting" current, as it is termed, is discontinued, the iron will usually remain magnetized. The remaining magnetism is called "residual," and its value is spoken of as "remanence." For example, if after an iron core has been fully magnetized and the exciting current withdrawn there should remain a magnetic flux of, say, 25,800 lines per square inch, the iron would be said to have shown a "remanence" of 25,800 in English measure, or 4000 gausses in metric measure. (The "gauss" is the unit of magnetic density in metric measure; 4000 gausses = 4000 lines of flux per square centimeter of path area = 25,800 lines per square inch of path area.)

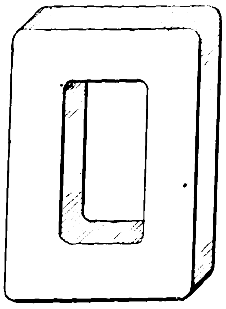


FIG. 1.

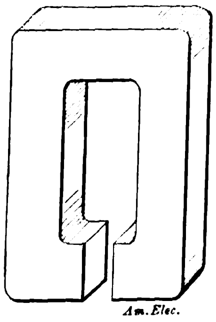


FIG. 2.

A completely closed circuit of iron, such as Fig. 1, will show much greater remanence than one with an air-gap, like Fig. 2. Consequently, if an electromagnet be allowed to draw its armature into actual contact with its poles, the armature will usually not fall away when the current is turned off, but will be held fast by residual magnetism. For this reason it is the universal practice to arrange all magnets and armatures so that actual contact between the latter and the magnet poles cannot occur. This is frequently done by setting a little pin of brass in the face of each magnet pole, allowing it to project barely enough to receive the blow of the armature and keep the latter out of direct contact with the iron of the pole.

Residual magnetism may be entirely dispelled by a sudden increase in the reluctance of the magnetic circuit, and sometimes by mechanical distrubance, such as violently jarring or hammering the magnet. It is due to a sort of magnetic inertia, known as "hysteresis," which is, simply stated, a tendency manifested by any magnetic material to resist any change—either increase or decrease —in its magnetic condition.

Another effect of hysteresis is to cause the magnetization of a core to lag behind the magnetizing current. For example, suppose a magnet has such a magnetic circuit as to make the relation between the exciting ampere-turns and the magnetic flux that shown by the curve *A*, in Fig. 3. If the current were adjusted to give precisely 250 ampere-turns, closing the circuit would not cause the magnet flux to rise *instantaneously* to 10,000 lines of force; it would attain that value within a very small part of a second (under ordinary conditions), but there would be an actual time interval between the closing of the circuit and the creation of the 10,000 magnetic lines of force. A part of this delay would be due to hysteresis and a part to a magneto-electric phenomenon known as self-induction, which will be treated in a future Lesson.

Referring again to Fig. 3: If the exciting current be increased gradually to 1800 ampere-turns, the magnetic flux will increase gradually to (in this particular case) 20,000 lines of force. Now, if the current be reduced step by step to zero again, the magnetic flux will be reduced, but not along the same line that it follows in rising; the successive values plotted to the same scale as before will give a curve on the order of the dotted-line curve *D*—invariably higher than the ascending curve, *A*. This is due to hysteresis, or magnetic inertia. The molecules of iron first resist magnetization, and when once magnetized, they resist demagnetization, so that when the exciting current has been reduced to zero there still remains some magnetism—in the particular case here cited it was 5000 lines of force.

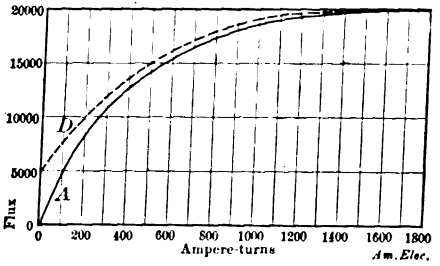


FIG. 3.—ILLUSTRATING THE EFFECT OF HYSTERESIS.

The effect of residual magnetism and that of suddenly opening a magnetic circuit is graphically shown by Fig. 4, which was plotted from tests of a small electromagnet, the armature of which was adjusted to lie within 1/10 in. of the magnet poles when unattracted and to be drawn into actual contact with them when attracted. The exciting force was increased gradually to 500 ampere-turns, and the magnetic flux increased almost in exact proportion, as indicated by the line *O-A*. A ruler laid near this line will show that it "dips" very slightly toward the right-hand end. This indicates that the reluctance of the magnetic circuit was almost constant up to that point. At 500 ampere-turns the armature yielded to the attractive force of the magnet and was drawn up against the poles, eliminating the air-gaps in the magnetic circuit more or less effectively. The result was the increase of the magnetic flux from 17,000 lines to 100,400 lines, as indicated by the straight line, *A-B*. Reducing the exciting current rapidly to zero, the magnetism fell as indicated by the curve, *B-C*, remaining at 57,100 lines after the current was cut off entirely, and as the remanent flux was more than three times the flux required to draw the armature up originally, the latter was held firmly against the poles. Jerking it away quickly caused the remanent magnetism to drop to practically zero, as indicated by the line, *C-O*.

Fig. 5 illustrates the result of preventing the armature from touching the magnet poles, and also the effect of increasing the reluctance of the magnetic circuit after the exciting current has been cut off. These curves and lines were plotted from a magnet having a little more than twice the cross-section of the first magnet and with stout manila paper pasted over the face of the armature to keep it out of magnetic contact with the poles. The armature was 3/16 in. from the magnet poles when unattracted, and weighted so as to yield to precisely 500 ampere-turns, as in the preceding case.

The flux increased in a straighter line *(O-A)* than before, because the air-gap formed a greater proportion of the total reluctance than in the first case, and the reluctance of air is constant. When the armature closed, the flux increased to 92,700 lines—less than in the smaller magnet, because the intervening paper between the armature and magnet poles maintained two small air-gaps in the magnetic circuit. Upon decreasing the current to zero, the magnetism fell to 25,100, as indicated by the curve, *B-C*, and as this final magnetism or "remanence" was less than the quantity required to lift the armature originally, the latter fell away without having to be pulled or struck away. The remanent magnetism then dropped to zero, as indicated by the line *C-O*.

In both of the foregoing cases, the curve *O-B* shows the manner in which the flux rose to its maximum with the armature held in its "closed" position—the same position occupied when the flux decreased along the curve, *B-C*. It should be noted that in Fig. 4 the flux increases much more rapidly than in Fig. 5. This is due to the fact that the armature of the magnet in the first case was in actual contact with the magnet poles, while in the case of Fig. 5 there was a layer of manila paper between the two, so that a greater number of ampere-turns was required to produce a given flux at any point of the curve than would have been required under the conditions of Fig. 4. The area enclosed by the lines and curves *C-O*, *O-B* and *B-C* in each case represents the amount of energy wasted in magnetizing and de-magnetizing the iron —wasted by hysteresis, in short. The area enclosed by *O-A-B-C-O* represents the total energy delivered to the magnet, and the area within *O-A-B-O* represents the energy utilized in lifting the armature.

It will be noted that the loss due to hysteresis in the case of Fig. 4, when the armature was in direct contact with the magnet poles, is relatively greater than in the case of Fig. 5, when manila paper was interposed. This is, of course, due to the fact that in the former case the remanent magnetism was considerably greater, in fact, so great as to necessitate striking the armature away from the pole-pieces. The energy thus delivered to the armature is entirely chargeable to hysteresis. From this comparison it will be evident that the better the magnetic circuit for a given grade of material, the greater will be the loss by hysteresis, which appears paradoxical but which, as will be explained in a later Lesson, is in reality entirely logical.

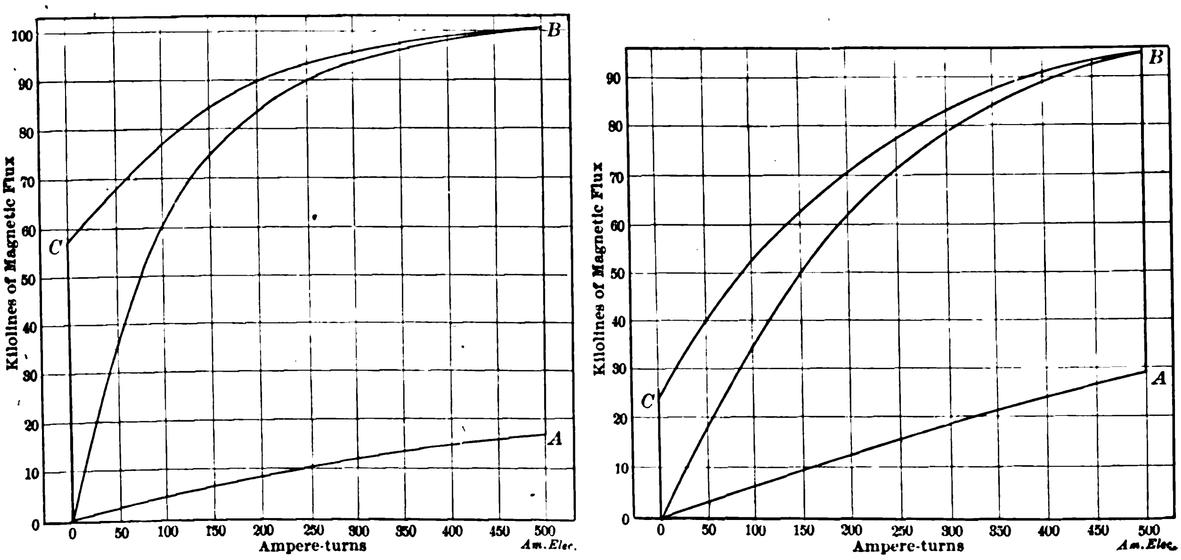


FIG. 4.—MAGNETIZATION AND DEMAGNETIZATION CURVES.—FIG. 5.

Letters on Practical Subjects

Armature Testing by Divided Circuits.

To the Editor, American Electrician:—

Referring to the article in last month's AMERICAN ELECTRICIAN by Mr. J. F. Motz, I wish to suggest that instead of rewinding the telephone receiver, it would be preferable to connect an ordinary receiver to the fine-wire winding of an induction coil, the coarse-wire winding being connected in circuit as the receiver was shown connected in Mr. Motz's diagram. A small fuse should be inserted in series with the coarse-wire winding of the induction coil. I think better results would be obtained with this arrangement than with the telephone receiver rewound with No. 24 wire and connected directly to the testing circuit, especially when testing a low-voltage armature wound with very heavy wire.

H. M. KEIFER.

Topeka, Kan.

Divided Control for Electric Gas Burners

To the Editor, American Electrician:—

Mr. Bond's communication concerning divided control for electric gas burners and your remarks thereon in the February issue of the AMERICAN ELECTRICIAN interested me somewhat. To my mind, the plan suggested in Fig. 2, of using additional batteries would cause trouble, as the two additional batteries are permanently on closed circuit through both magnets of both burners. It would seem that the simplest way to solve the problem would be to install ordinary double-contact push-buttons on the upper floor, as shown by the accompanying sketch (Fig. 1) herewith.

C. N. THOMAS.

Lynn, Mass.

[We have received a similar communication from Mr. Charles J. Sutter, St.

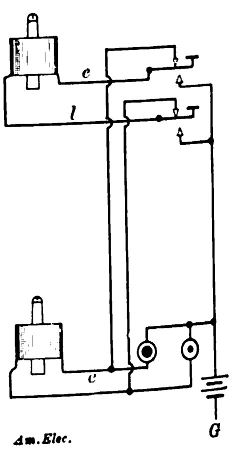
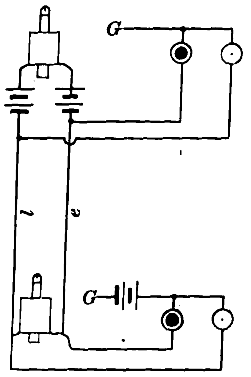


FIG. 1.—ELECTRIC GAS BURNER CONNECTIONS.

Louis, Mo., who suggests exactly the same arrangement as that shown by Mr. Thomas in Fig. 1. The arrangement in Fig. 2, which was published last month, is impractical, as Mr. Thomas and Mr. Sutter have pointed out, and we are rather surprised that this has not been noticed by more of our readers. The arrangement shown by Fig. 3, which was also suggested last month, appears to have equal merit with that of Fig. 1.—EDITOR.]



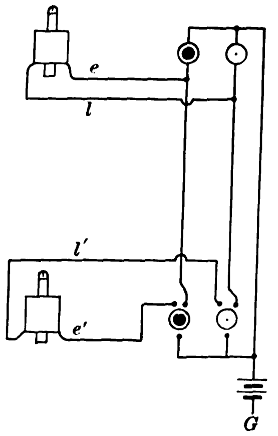


FIG. 2.—ELECTRIC GAS BURNER CONNECTIONS.—FIG. 3.

Mr. Cavanaugh's Problem in Lamp Control.

To the Editor, American Electrician:—

Enclosed please find a diagram (Fig. 1), which will fulfill the conditions imposed by Mr. J. A. Cavanaugh in his letter published in your February number. The upper leads from all of the outlets go direct to the tablet board, as shown, and the lower leads go to a two-way single-pole switch, commonly known as a three-point switch. Outlets 6 and 7 are provided with double-station control, consisting of two three-point switches connected in the usual manner, the circuit being completed by leads from the "heel" points of the lower switches to the fuse-connections on the tablet board. The "off" contacts of the individual switches controlling the first five outlets are all connected together, and the combined lead carried to one jaw of an ordinary three-pole single-break knife switch. Extra leads are carried from the outlets 6 and 7 to the other two jaws of the knife switch. The blades of the switch are all connected together and to the upper main bar of the tablet board. It is obvious that closing the knife switch, *E*, will close the circuit through all of the outlets regardless of the positions of the individual switches; *a*, *b* and *c* are fuses in the auxiliary outlet leads from the emergency switch. If the total number of lamps supplied from the first five outlets should be greater than the underwriters would allow a single fuse to protect, this objection could be met by using a double-break four-blade knife switch as the emergency switch and carrying individual leads from the jaws of the emergency switch to the lower left-hand points of the individual switches controlling the first five outlets.

GEO. W. MALCOLM.

Brooklyn, N. Y.

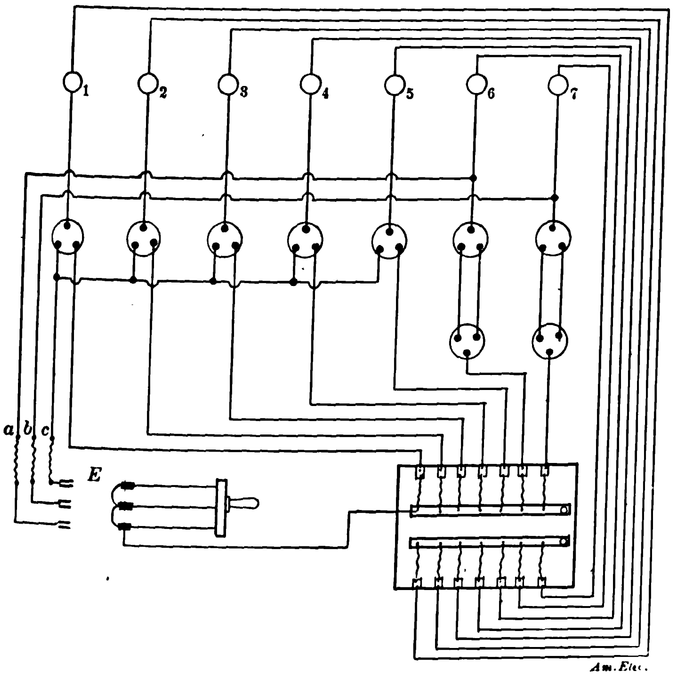


FIG. 1.—MR. MALCOLM'S AND THE AUTHOR'S SOLUTION.

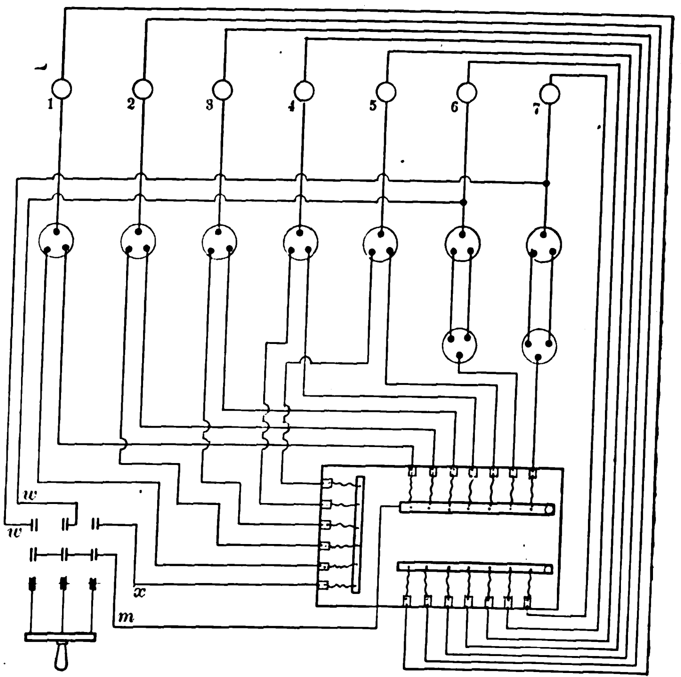


FIG. 2.—MR. CLARK'S SOLUTION.

To the Editor, American Electrician:—

The accompanying diagram (Fig. 2) is submitted as a solution of Mr. Cavanaugh's problem which appeared in your February number. All of the individual switches are of the three-point type. The double-station control for outlets 6 and 7 is of the ordinary character, and both leads from each outlet are fused. The emergency leads from the first five outlets are also fused. The emergency switch is a triple-pole double-break knife switch with three of the jaws connected together and connected by the wire *m* to the panel-board bar, from which the individual switches disconnect the outlets. The other three jaws of the switch are connected to the emergency leads. An auxiliary set of fuse links is provided on the tablet board for the emergency leads from the first five outlets, and the bus lead, *x*, is also fused. I shall be interested to see how other readers handle this problem.

HAZEN CLARK.

Middlesex, Vt.

[A solution practically identical with this was sent in by Mr. Rene Moncel, Montreal, Canada; the only differences between Mr. Moncel's solution and Mr. Clark's are that Mr. Moncel inserts fuses in the emergency leads, *w* and *w*, and does not fuse the lead *x*.—EDITOR.]

To the Editor, American Electrician:—

Enclosed please find a solution (Fig. 3), of Mr. J. A. Cavanaugh's problem published in the February number of the AMERICAN ELECTRICIAN. The emergency switch, *E*, is a double-pole double-break knife switch with the blades electrically connected together. One jaw is connected to the main bar on the tablet board, another jaw to the auxiliary bar on the tablet board, from which fused leads are carried to the emergency points of the individual switches, and the other two jaws of the emergency switch are connected through fuses on the tablet board to the leads from outlets 6 and 7 above the individual switches for those outlets, so as to make the emergency switch independent of the individual switches. All of the individual switches are of the three-point type, the double-station control for outlets 6 and 7 being obtained in the usual manner. There is a limit to the number of outlets that can be controlled from two or more points when an emergency switch is used. If the system had more than four such outlets in addition to the outlets controlled by single switches, it would necessitate a specially-made emergency switch, as a three-pole double-break switch is the largest, I think, that is carried in stock.

Wm. A. Loveland.

Wilmington, Del.

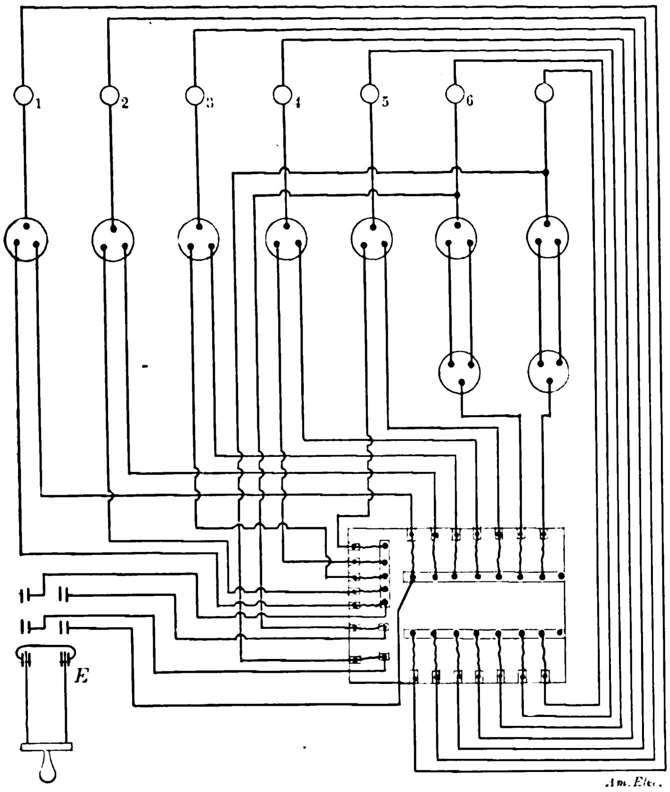


Fig. 3.—Mr. Loveland's Method of Wiring.

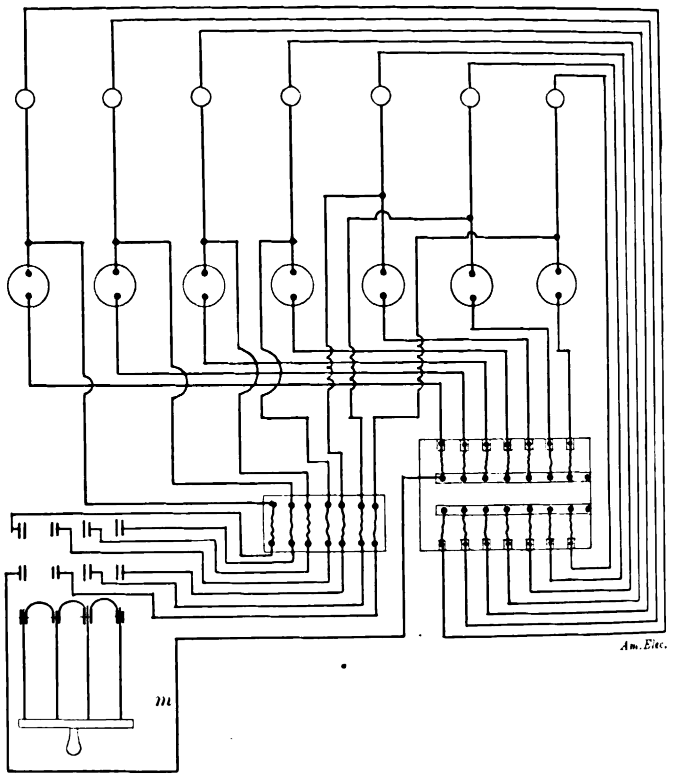


Fig. 4.—Mr. Kennedy's Method of Wiring.

To the Editor, American Electrician:—

I enclose a sketch (Fig. 4) giving a solution of Mr. Cavanaugh's problem in lamp control which appeared in the February number of your paper. As will be seen from the diagram, one side of each outlet is carried straight to fuses on the tablet board. The other lead, from each of the first five outlets, goes to a fuse on the tablet board through a single-pole snap switch. Outlets 6 and 7 are connected to the tablet board fuses through two three-point switches, giving double-station control. Auxiliary emergency leads are carried from each outlet through fuses to the jaws of a four-blade knife switch, which serves as the emergency switch. There being seven of these leads, one jaw of the emergency switch is left for the lead from the main bar on the tablet board. The blades of the switch are all connected together electrically. Closing the emergency switch will, therefore, connect all of the outlets to the tablet board through auxiliary fuses, regardless of the positions of the individual switches.

Carlton L. Kennedy.

Braintree, Mass.

To the Editor, American Electrician:—

The accompanying sketch (Fig. 5) is submitted as a solution of Mr. Cavanaugh's problem in lamp control. The diagram is practically self-explanatory. One side of each of the outlets is carried to a fuse on the tablet board, and the other side to the heel of a three-point switch, *s*. The double-station control for the outlets 5 and 6 is provided by using a double-pole double-throw switch, *S*, in conjunction with the two-way single-pole switches. The emergency leads from the various switches go to auxiliary fuses on the end of the tablet board, and the bus-bar for this group of switches is connected by the emergency switch, *E*, to the main tablet board bar, from which the individual switches disconnect the outlets. The four-point switches, *S S*, when thrown to one position connect the wires *a a* to the fuses in the main bar on the tablet board, and the wires *b b* to the auxiliary fuses; when thrown to the other position these connections are simply exchanged, the wires *a a* being then connected to the auxiliary fuses and the wires *b b* to the fuses in the main bar.

C. Barnard Arseno.

Boston, Mass.

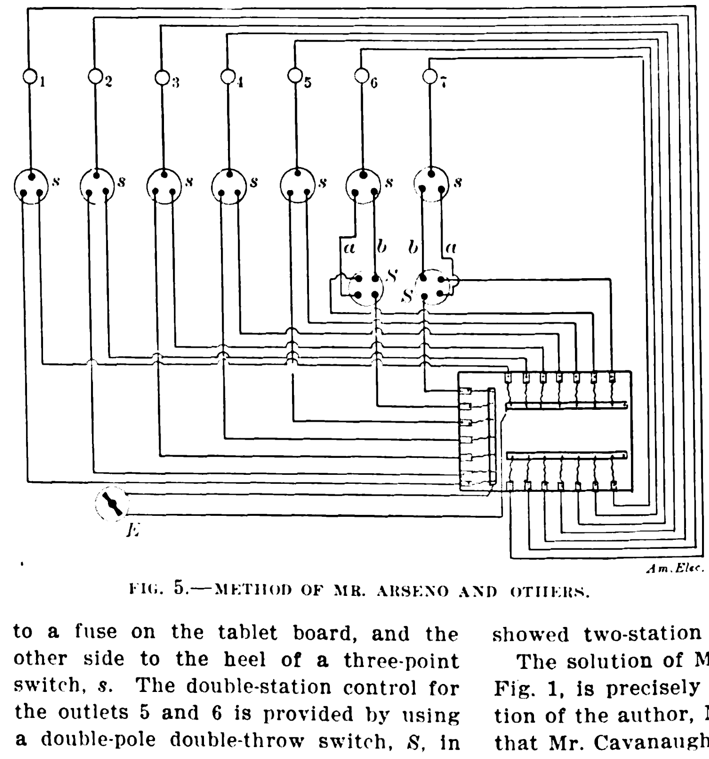


Fig. 5.—Method of Mr. Arseno and Others.

[This solution was also sent in by C. H. Hodgkins, Providence, R. I.; Burton E. Lucas, Delray, Mich; Wm. Steinaker, Jr., Buffalo, N. Y.; Chas. J. Sutter, St. Louis, Mo., and W. E. Tower, Mattoon, Ill. Mr. Sutter's diagram, however, while exactly like Fig. 4 in all other respects, showed two-station emergency control.

The solution of Mr. Malcolm, shown by Fig. 1, is precisely the same as the solution of the author, Mr. Cavanaugh, except that Mr. Cavanaugh's diagram did not indicate the fuses *a*, *b* and *c*. The solution shown by Fig. 2 is obviously an improvement over Fig. 1 in that every one of the first five outlets is provided with double fuses, no matter whether the circuit is closed by an individual switch or by the emergency switch. When the emergency switch is closed, the outlets 6 and 7 are individually fused on one side, and are protected jointly on the other side by a single fuse in the lead, *x*. This might or might not be contrary to the underwriters' rules, according to the number of lamps supplied from the outlets. Mr. Moncel's solution removes this contingent objection by inserting fuses in the leads *w* and *w*, providing every outlet with double fuses irrespective of the point at which the circuit is closed.

The solution shown in Fig. 3 is practically identical with that shown in Fig. 2, if the leads *w* and *w* are considered fused, as Mr. Moncel's solution provided, but is somewhat preferable to the latter, because of the use of a double-pole emergency switch instead of one with three blades. It will be obvious that a double-pole switch could be substituted in Fig. 2 by connecting the blades together and carrying the wires *m* and *x* to the other two jaws.

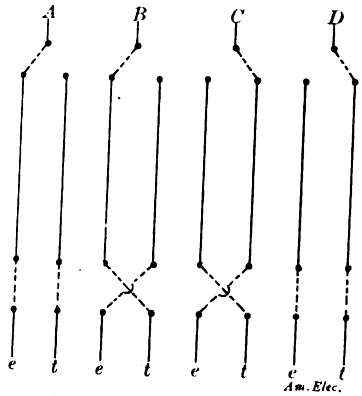


FIG. 6.—DOUBLE STATION CONTROL.

Mr. Kennedy's solution in Fig. 4, while somewhat simpler in the matter of individual control, involves more elaborate connections at the emergency switch on this account. Mr. Kennedy's original sketch showed the seven auxiliary fuses mounted on the end of the main tablet board instead of on a separate block as here shown. The sketch was changed merely to clarify the diagram and avoid a multiplicity of crossings.

The simplest of all the operative solutions that have been received is that shown in Fig. 5. In this solution a single-pole emergency switch is used, and the only additional complication in any other part of the diagram is the use of pole-changing switches, *S S*, instead of the single-pole two-way switches used by the other contributors. In this connection it may be advisable to explain more in detail the operation of these switches, and the accompanying sketch, Fig. 6, is submitted for that purpose. At *A* the single-pole and double-pole two-way switches are shown in one position; at *B* the single-pole switch is shown in the same position, but with the double-pole switch in the other position; transposing the connections at *C* the double-pole switch is shown in its second position and the single-pole switch thrown to the other side; at *D* the single-pole switch is shown thrown to the right, and the double-pole switch restored to its original position. The letters *e* and *t* indicate the leads that go to the emergency-circuit fuses and those that go to the regular tablet-board fuses.—EDITOR.]

Electrical Catechism

669. What is meant by the "electrochemical equivalent?"

The electro-chemical equivalent of an element is the amount liberated by one coulomb. Experiment shows that one coulomb (1 amp. flowing for one second) will liberate 0.000010384 gram of hydrogen from water or other compound. As hydrogen is the lightest element known, its weight is taken as unity, or the basis of comparing the weights of atoms of other elements. The various elements are also classified according to their "valency," or the power they have of uniting with other elements. Thus one atom of oxygen will unite with two atoms of hydrogen to form one molecule of water (H_2O), and oxygen is, therefore, said to be a dyad or to have a valency of two. Other elements have a valency of one, two, three, or four. The electro-chemical equivalent of an element is therefore the atomic weight multiplied by 0.000010384 and divided by the valency.

670. What are the laws of electrolytic action other than those of Faraday?

(4.) Liberated ions appear at the electrodes only.

(5.) Every electrolyte is decomposed into two portions, an anion and a cation, which may be themselves either elements or compounds. Thus water (H_2O) is decomposed into hydrogen and oxygen; but when current is sent through a solution of copper sulphate ($CuSO_4$), copper is liberated at the cathode, while the "sulphion" (SO_4) travels to the anode, with which it usually unites to form a sulphate.

(6.) In binary compounds (those composed of two elements) and most metallic solutions, the metal is deposited at the cathode; thus in electroplating, the object to be plated is made the cathode.

(7.) Aqueous solutions of salts of the alkaline metals (potassium, sodium, lithium, cæsium, rubidium) and of the alkaline earths (calcium, barium and strontium) deposit no metal, but evolve hydrogen owing to the secondary action of the metal upon the water. Thus, when current is sent through a solution of common salt (NaCl) in water, chlorine gas is given off at the anode; but instead of metallic sodium appearing at the cathode, it unites with the water as fast as liberated from the salt and forms sodium hydrate (NaOH) or caustic soda, and in turn liberates hydrogen, which escapes as a gas.

(8.) Metals can be arranged in a definite series according to their electrolytic behavior, the more oxidizable metals being more strongly electro-positive; but the order varies with the nature, strength and temperature of the solution used. Each metal, when electrolyzed from its compound, behaves as a cation in preference to one more electro-negative. This is the basis of methods of electrolytic refining of metals, such as copper. On the other hand, alloys, such as brass, may be deposited electrolytically by using such solutions that the component metals dissolve with equal e.m.fs.

(9.) Several metals will be deposited at once from a solution of mixed salts, if the current strength is so great that the solution near the cathode becomes weak. For example, in refining copper, the silver and other impurities remain in the solution while the copper alone is deposited, unless the current strength increases or the amount of copper in the solution near the cathode becomes less, when the greater resistance causes such a high difference of potential that the silver is deposited with the copper on the cathode.

(10.) For each electrolyte a minimum e.m.f. is requisite, without which complete electrolysis will not occur, though temporary polarization may exist. In such a case, a small current may flow for a short time, but the polarization immediately causes a counter e.m.f., which stops the further passage of current.

(11.) When both electrodes are of the same metal in their own salt, there is no opposing e.m.f., since no net chemical work is done, and the smallest e.m.f. will effect deposition. For example, in the Edison chemical meter, electrodes of amalgamated zinc are immersed in a solution of zinc chloride and connected around a shunt of low resistance. The current divides between the shunt and the "bottle," and a definite proportion of the total current passing through the electrolytic cell transfers a definite amount of zinc from the anode to the cathode, no net chemical work being done, as the zinc is simply transferred from one plate to the other. This also is important in electrolytic refining of metals.

(12.) Where the ions are gases, voltage affects the conditions but slightly. Thus, one ampere passing through acidulated water liberates 0.0000103 gram of hydrogen each second, and it matters not if the hydrogen escapes into the open air into a vacuum or into a receiver under a pressure of many pounds per square inch. The e.m.f. necessary to effect decomposition increases to some extent with the pressure on the gas, but the given current liberates the same weight of gas in any case.

(13.) The chemical work done in a cell is proportional to the minimum e.m.f. necessary for polarization, and any additional e.m.f. simply represents the energy used in heating the cell.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What is the proper lubricant to use for a drill in drilling glass? C. N.

Camphor and turpentine are frequently used, but soap and water will ordinarily answer the purpose.

Which is the preferable location for the blow-off opening in a horizontal tubular boiler; in the under sheet of the shell, or in the head, just above the bottom of the boiler? J. H. T.

In the under sheet, near the back head.

Is there any danger in admitting live steam to an idle boiler filled with cold water up to the ordinary working level? W. I. C.

Not if the steam is admitted very gradually. If it should be admitted suddenly, unequal expansion of different parts of the boiler would occur and probably cause damage.

If a direct-current enclosed arc lamp takes 5 amperes and 80 volts across the arc, is the consumption on a 110-volt circuit 400 watts or 550 watts? J. W. H.

The total consumption is 550 watts unless the difference between the voltage at the arc and the voltage of the circuit is taken up by a reactance coil, in which case the actual power consumed would be somewhere between 400 and 550 watts, according to the resistance of the reactance coil and any other windings in series with the arc.

How many volts are required to charge a storage battery? (2). How is the proper charging current ascertained? (3). Should the cells be connected in series or parallel? C. M.

The charging voltage should have a maximum value of 2¾ volts per cell of battery, when the cells are connected in series. (2). From the manufacturer. (3). This depends upon the number of cells and the available charging voltage. If the source of charging current is already at hand, dividing it by 2¾ will give the number of cells that can be connected in series.

Can an alternating-current fan motor, built for 125 cycles, be rewound for 60 cycles? (2). If so, what changes should be made in the winding of an eight-pole machine? R. B. K.

Yes, after a fashion. (2). The connections of half the magnet coils must be reversed, so that if a direct current were passed through the field winding the magnet poles would be grouped in pairs of like polarity. Thus, an eight-pole machine would have two north poles side by side, then two south poles, next two north poles, and finally two more south poles, with direct current in the winding. This arrangement, however, seldom gives satisfactory results in practice.

At what speed should an incandescent lamp be rotated in making photometric tests? R. P. S.

180 r.p.m.

What advantages have three-phase currents over two phases for the operation of induction motors? (2). Do central stations charge for true watts or apparent watts? A. E. E.

Practically none. (2). For true watts.

Will the 1-h.p. gas engine described in the December, 1901, number drive the dynamo described in the September, 1901, number? H. A. S.

Not under full load; the dynamo requires a 3-h.p. engine to drive it at full load.

What is the proper height above the ground for open arc lamps of 2000 candle-power nominal? B. E. M.

This depends entirely upon local conditions. In a narrow, crowded street, with lamps at frequent intervals, the lamp should hang about 20 to 25 ft. above the ground. In wide streets or large open areas, the height can be advantageously increased to 30 or 40 ft.

Can steam from a high-pressure boiler be used for heating purposes and also for operating the engine at the same time? If so, how? W. B. L.

If the boiler has sufficient surplus capacity beyond that required for operating the engine, the heating system may be supplied with steam taken direct from the boiler and passed through a regulating valve to reduce the pressure of the steam to a relatively low figure before delivering it to the heating system. A more usual method is to deliver the exhaust steam from the engine to the heating system.

I have made an induction coil with a core 1 in. in diameter and 1¼ ins. long, of annealed iron wire; primary coil, three layers of No. 18 s. c. c. wire; secondary coil, 2½ lbs. No. 30 d. c. c. wire in four sections, boiled in paraffine. The coil only gives a ⅛-in. spark. What is the trouble? W. G. H.

One defect is that the ratio of secondary to primary turns is too small; another is that the insulation of the secondary wire is insufficient; a third is that the coil is too short, forcing the outer layers of the secondary coil farther away from the core than should be. A core 1 in. in diameter should be at least 8 ins. long and preferably 10 ins. The primary wire should be No. 36 double silk-covered.

What is the formula for line losses in a constant-current alternating circuit, and how is the size of wire determined? H. A. B.

The formula for direct-current drop in a series circuit is:

$$\frac{10\frac{1}{2}\,L\,I}{d^2} = V.$$

This formula may, of course, be transposed to solve for the size of wire as follows:

$$\frac{10\frac{1}{2}\,L\,I}{V} = d^2.$$

In these formulas *L* is the actual length of wire, *I*, is the current that it carries, d^2 is the cross-section in circular mils, and *V* is the drop in volts. These formulas are sufficiently accurate for alternating-current work, although the actual drop will be somewhat more than the formula shows, on account of the inductance of the line.

Can an ordinary direct-current motor be converted into an alternating-current induction motor? W. G. P.

No.

How can the horse-power of a gas engine be approximately determined without the use of an indicator? A. R. W.

It is not possible to estimate the horsepower of such an engine without a thorough knowledge of the fuel that is to be used, and even then the estimate would not be of any practical value, because the actual ability of the engine could not be calculated within 25 per cent.

What is the difference between a non-inductive watt-hour meter and an inductive wattmeter? (2). Which of the two is preferable? C. H.

An inductive meter is one in which the moving member is not connected directly to the circuit, but has currents induced in it by the stationary windings, as in the case of an induction motor. A non-inductive meter is one embodying coreless field coils and an armature provided with windings and a commutator; the Thomson meter is the only one of this class. (2). Both have advantages and disadvantages with relation to each other; there is usually no preference.

How can the positive and negative terminals of a generator be identified without the use of complicated apparatus? (2). Can compound-wound generators be operated in parallel without an equalizer? (3). How can compound-wound generators which are not compounded alike be made to run in parallel? H. P. N.

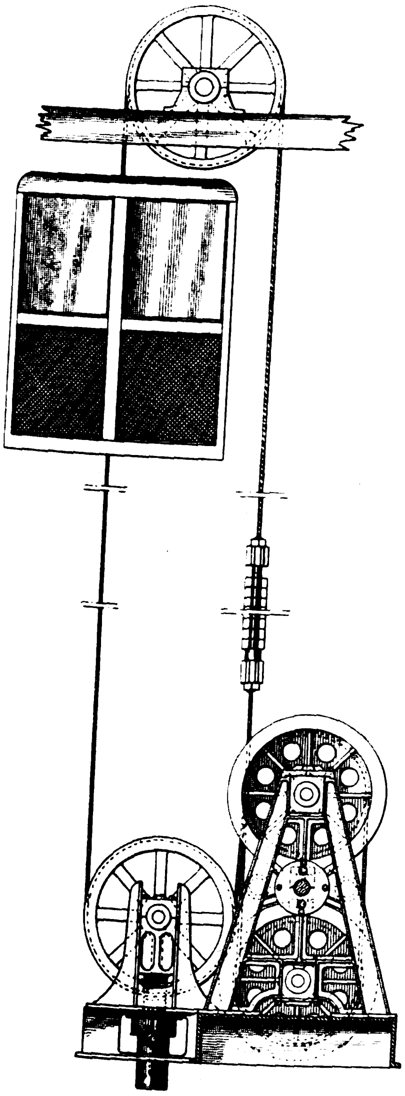
To the terminals of the machine connect a voltmeter of any make in which a permanent magnet is used; if the needle is deflected over the scale of the voltmeter, the binding post marked + is connected to the positive terminal of the machine; if the needle is thrown away from the scale against the back stop, the terminal to which the + binding post is connected is negative. (2). No. (3). By inserting sufficient resistance between the series field terminal of the stronger machine and the main switch to reduce its compounding to the same percentage as that of its mate.

Why is a receiver more necessary for a cross-compound engine than for a tandem-compound engine? (2). How is the failure of a condenser liable to wreck an engine? H. W. S.

In a cross-compound engine the cranks are usually at right angles, so that the admission valves of the low-pressure cylinder are closed when the exhaust valves of the high-pressure cylinder are open. Consequently, a receiver must be provided into which the high-pressure cylinder can exhaust. In a tandem-compound engine the two pistons drive a single crank, so that the admission valve at the back end of the low-pressure cylinder is open at practically the same time that the exhaust valve at the front end of the high-pressure cylinder is open, and *vice versa*; hence the steam can pass directly from one to the other. (2). By having the condenser fill with water which may back up into the engine cylinder.

A NEW ELEVATOR HOISTING MECHANISM.

The accompanying engravings illustrate a form of elevator gear which has been devised and patented by Mr. M. E. Neenan, New York City. The system belongs in the general class of continuous-cable mechanisms, the hoisting cable passing several times around the two drums on the right of Fig. 1, one located immediately above the other. The single sheave at the left of the hoisting mechanism is a tension sheave to keep taut the return cable to the car. The counterbalance is mounted directly in the line of hoisting cables between the hoisting drums and the overhead sheave, as clearly shown, so that no additional counterbalance cables are required. The two hoisting drums are mounted on bearings which are slidable up and down in the *A* frame, and each drum is provided at each end with a friction drum, as indicated in Fig. 2. Between the two sets of friction drums is a small friction roller, the shaft of which is coupled directly to the shaft of the motor. It will be evident that the weight of the upper hoisting drum, combined with the tension of the hoisting cables, draws the two drums into firm contact with the friction roller driven by the motor, and power is thus transmitted from the motor to the hoisting cables. This method of mounting the hoisting drums is claimed by the inventor to reduce the friction of their bearings very materially. In fact, it will be obvious that the principal friction is taken by the stationary bearings of the motor-driven roller, and that the weight of the upper hoisting drum largely compensates the upward pull of the hoisting cables, and thereby reduces the friction in the bearings of this motor-driven roller. In order to prevent the car from descending when its load is sufficient to overbalance the counterweights, a powerful brake, of course, must be provided on the motor shaft. This also applies to the condition when the counterbalance is considerably heavier than the car and its load.



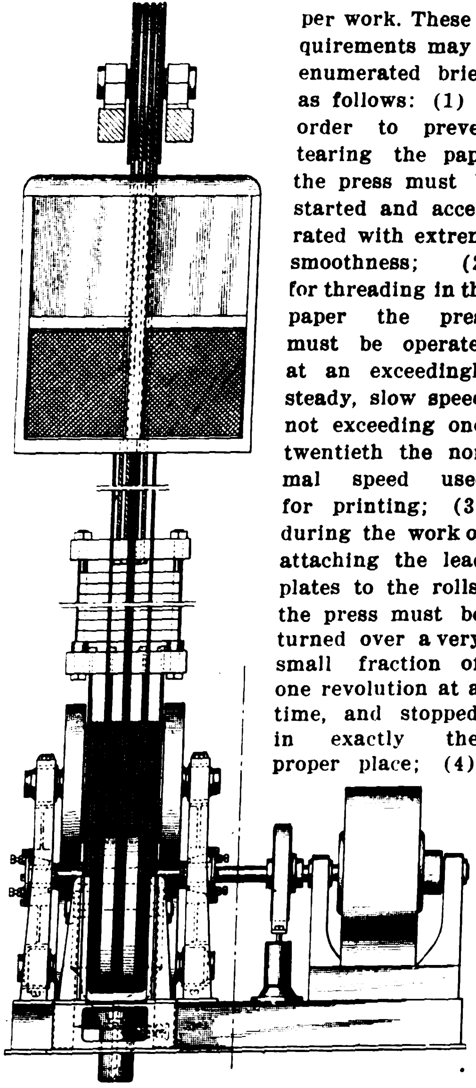


FIG. 1.—ELEVATOR HOISTING MECHANISM.—FIG. 2.

* * *

SYSTEM OF ELECTRIC DRIVE FOR LARGE NEWSPAPER PRESSES.

BY H. H. CUTLER.

In adapting electric motors for driving large newspaper presses it is necessary to provide for many requirements peculiar to newspaper work. These requirements may be enumerated briefly as follows: (1) In order to prevent tearing the paper the press must be started and accelerated with extreme smoothness; (2) for threading in the paper the press must be operated at an exceedingly steady, slow speed, not exceeding one-twentieth the normal speed used for printing; (3) during the work of attaching the lead plates to the rolls, the press must be turned over a very small fraction of one revolution at a time, and stopped in exactly the proper place; (4) arrangements are necessary for quickly and positively stopping the press in case the paper breaks or the folder clogs, or anything else occurs which necessitates a quick stop; (5) for printing different quantities of paper and for using different kinds of ink it is necessary to operate the press at speeds corresponding therewith, which speeds vary over a wide range; (6) in order to insure the safety of the operators while making ready, it is advisable to provide means under their control which will absolutely prevent the press from being started while they are at work upon it.

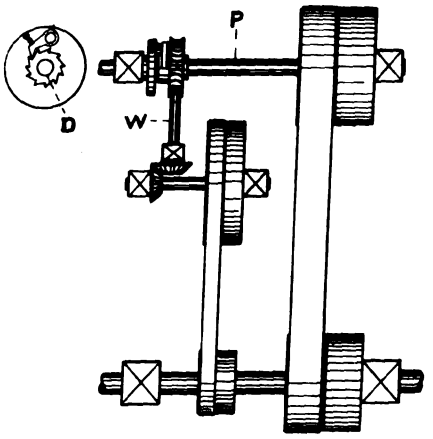


FIG. 1.—SLOW-SPEED GEAR.

The foregoing requirements can, at best, be only partially fulfilled by any method which does not employ the electric drive. At least one printing press manufacturer, however, has been furnishing for many years presses equipped with a mechanical slow motion device which is of especial interest in this connection, as it has been utilized in adapting the particular system of electric drive described in this article. Fig. 1 illustrates the method referred to, which is frequently used by R. Hoe & Co. for mechanically driving large presses.

A main shaft is supported by hangers at the top of the press room and connected by means of two independent belts to countershafts and gearing mounted on the press-room floor. Both belts are provided with belt shifters arranged to slide the belts from loose to tight pulleys mounted on the countershafts. The larger belt shown in the engraving passes directly around a tight or loose pulley on the press shaft and drives this shaft at a speed suitable for printing. The smaller belt drives a small countershaft connected by means of miter gears to another countershaft at right angles to the first. This second shaft carries a worm, meshing with a worm wheel mounted loosely on the press shaft, *P*, and carries a pawl arranged to engage with the teeth of a ratchet wheel keyed to the press shaft.

It is evident, therefore, that whenever the smaller belt is active the worm wheel will revolve, and its pawl will press against the teeth of the ratchet wheel and thereby cause the press shaft to revolve at an extremely slow speed. As soon as the larger belt is shifted to the tight pulley on the press shaft the ratchet wheel will be driven by it at a much greater speed than that of the worm wheel, thus allowing the pawl to clatter over the teeth of the ratchet wheel. It is evident, then, that both belts may be connected to the tight pulleys or either one of them alone without interfering in the least with the functions of either belt. It is apparent, however, that a mechanical arrangement of this kind would allow the press to be operated at but two speeds, one very slow speed for threading in the paper and a much faster speed for printing the same.

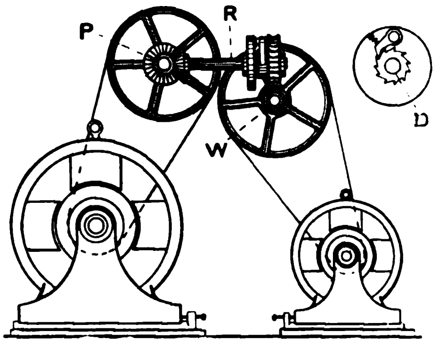


FIG. 2.—DOUBLE-MOTOR GEAR.

In order to meet the requirements stated in the beginning of this article, it is necessary to provide a wide range of speed. Now, since this type of Hoe press is usually arranged to be driven by two belts, it is at once apparent that each belt can be driven by an independent motor, and this plan was adopted last spring for driving a new sextuple Hoe press installed for the New York *Journal* in its auxiliary press room located under the Brooklyn Bridge.

Fig. 2 shows the two motors as they are installed in this plant, and Fig. 3 illustrates the controller, which was especially designed for this two-motor equipment by the Cutler-Hammer Manufacturing Company. This controller is capable of changing the speed of both motors through a range of practically 50 per cent by the usual rheostatic method.

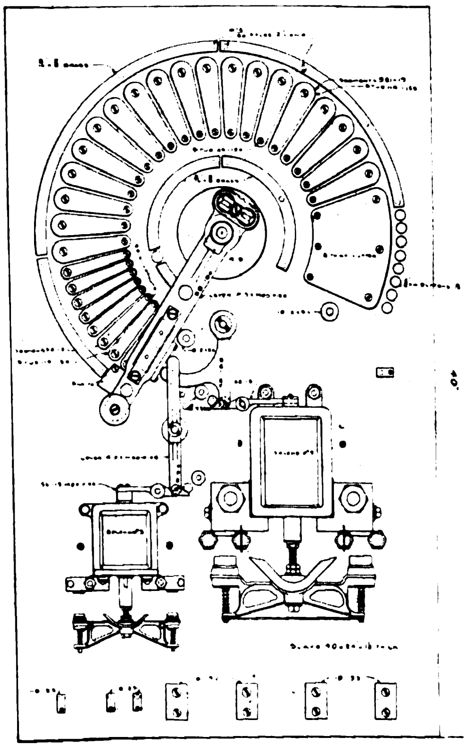


FIG. 3.—DOUBLE-MOTOR CONTROLLER.

The lower part of the controller contains the segments and resistance suitable for a 10-h.p. motor, and the upper part of the controller contains similar provision for a 60-h.p. motor. The two solenoid-controlled switches, clearly shown in the engraving, are utilized for closing the main line circuits for the two motors, respectively. The windings of these solenoids are connected in circuit by means of a small brush mounted on the end of the controller lever, and arranged to press against a narrow brass segment shown surrounding the resistance segments on the controller front. This ring is cut at the place where the controller arm cuts out all the resistance in the small motor circuit and the speed-controlling resistance for the large motor becomes active. As the small brush in the end of the rheostat lever leaves the lower part of this narrow brass segment it de-energizes the solenoid switch which controls the small motor circuit, and at the same time energizes the solenoid switch which controls the circuit of the large motor, stopping the small motor and accelerating the large motor. This gives an increase in the speed of the press, which can be further increased by cutting out the resistance of the controller from the armature circuit and still further increased by introducing rheostatic resistance into the shunt field circuit, as provided for by the extra contact buttons shown in the cut.

It is also possible, by means of this controller to start and stop the press and move it an extremely small fraction of an inch without calling upon the lines for over 10 horse-power of current, and without producing any flashing or burning on the segments of the controller.

It then becomes impossible to again start the press until the controller arm is moved back mechanically to the "full off" position. This is accomplished by the mechanism shown in the engraving, which allows the solenoids to close their switches only when this mechanism has been put in the proper position by moving the controller handle to the "full off" position.

It is sometimes desirable to arrange controllers for printing press work so that they can be started as well as stopped from several different places, and also have their speed increased or diminished at these several different places. It is customary, for example, to slow down the press when the roll of paper is nearly exhausted, and apparatus is in use whereby an extra roll of paper can be pasted onto the end of the nearly exhausted roll without stopping the press; the press is slowed down merely by pushing the "slower" button.

Fig. 4 shows a controller arranged to be operated from six different stations by means of three push-buttons located at each station. The controller shown in this cut has been operating for several months a full-size Hoe "quad." press for the Minneapolis *Tribune*. The buttons are arranged in a vertical row at each station, and labeled "Faster," "Slower" and "Emergency." Pressing the button marked "Faster" will start the press by means of the small motor, which motor will be gradually and automatically accelerated so long as any one of the "Faster" buttons is kept depressed; as soon as the desired speed is obtained, the finger is removed from this button, and the motor continues at this speed. To make the press go slower it is only necessary to press the middle button at any one of the stations, and the press will continue to decrease in speed so long as the "Slower" button remains depressed.

To stop the press quickly the "Emergency" switch is opened. This switch is the bottom one at each push-button station, and consists of a 10-ampere modified Bryant snap switch, which carries the fraction of an ampere necessary for energizing a solenoid switch controlling the main-line circuit. The circuits are so arranged that if any one of these little emergency switches is opened the press cannot be started until it is closed. When all of the emergency switches are closed, a lamp on the controller is lighted; so that the operator can always tell if his emergency switches are closed by looking at the controller.

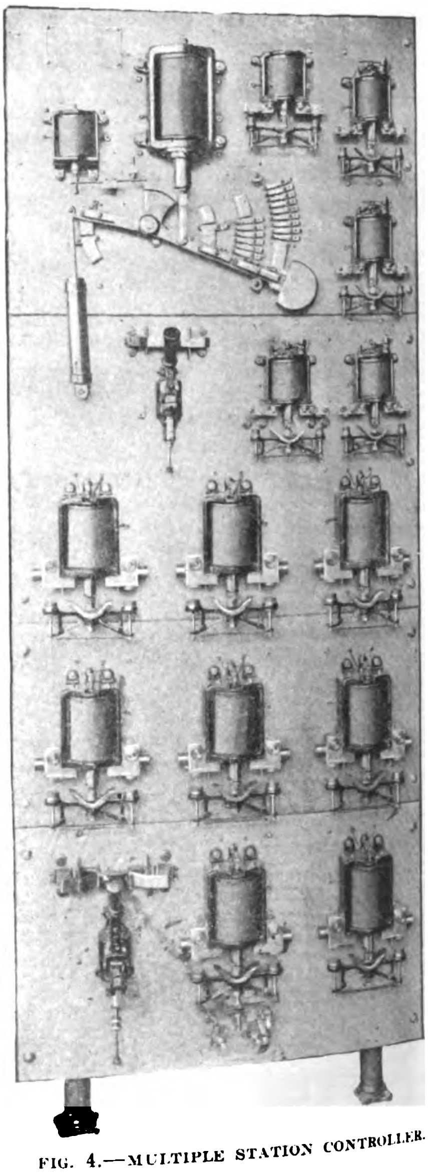


FIG. 4.—MULTIPLE STATION CONTROLLER.

New Apparatus and Appliances

FLASHLESS INDICATOR FOR FUSES.

A new indicating feature which shows when a fuse is blown has been recently applied by the D. & W. Fuse Company, of Providence, R. I., to the well-known D. & W. enclosed fuses. It is designated the "Bull's-Eye" indicator on account of its appearance, and is said to be flashless, quiet and reliable in operation. Figs 1 and 2 show two fuses provided with the indicating attachment. A small circle, or bull's-eye, will be noticed near the center of the fuse in Fig. 1. This acts as a sort of target which, when the fuse is normal, is perfectly blank, as shown in the engraving mentioned. When the fuse has blown a small black spot appears in the circle, as shown in Fig. 2, and serves as an indication to that effect. The indicator has been adopted as standard by the D. & W. Fuse Company, and is said to have met the general approval of those who have tried it.

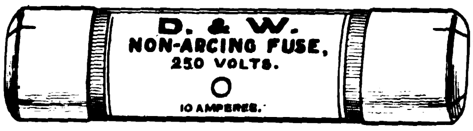


FIG. 1.—INDICATOR WITH FUSE NORMAL.

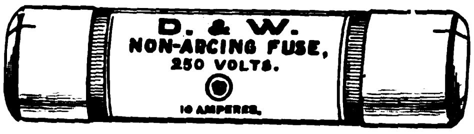


FIG. 2.—INDICATOR WITH FUSE BLOWN.

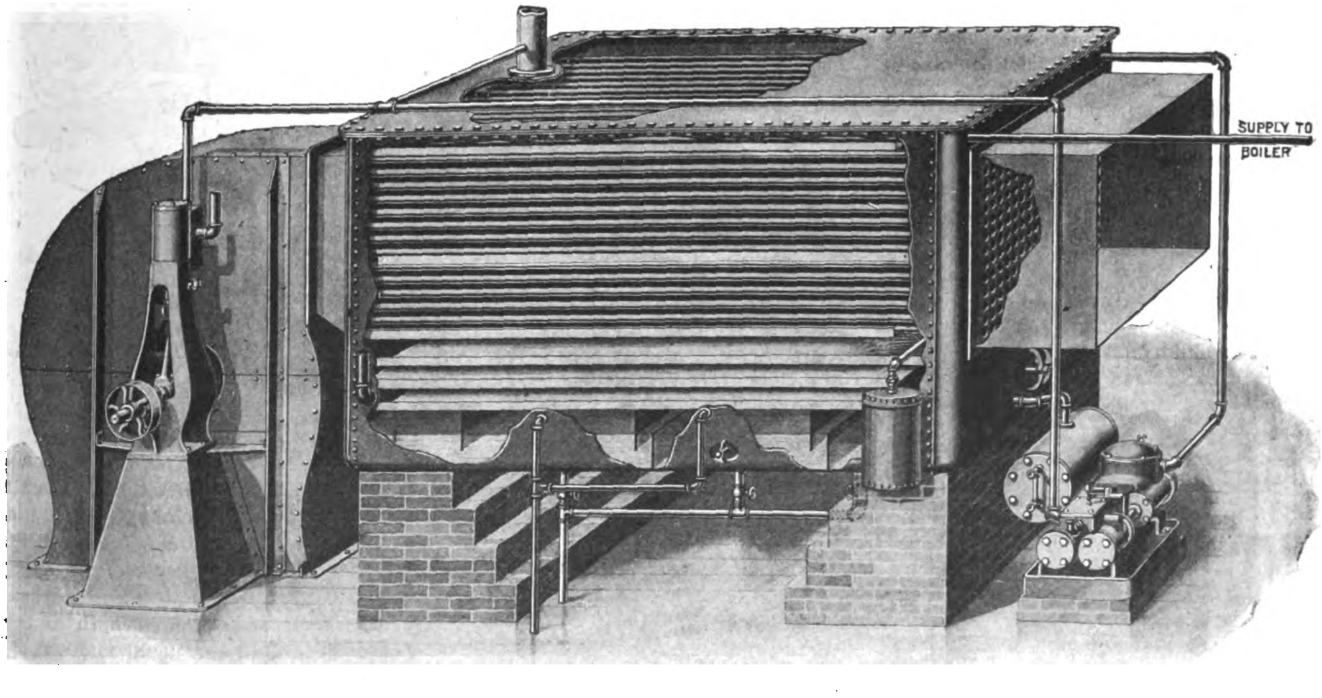


FIG. 3.—KELLER COMBINATION HEATER CONTAINING HOT AIR BLAST ATTACHMENT, OIL SEPARATOR AND AUTOMATIC FEED.

KELLER FEED-WATER HEATER.

The Keller feed-water heater, with which is combined a purifier, condenser the hot-air blast device, is shown by Fig. 3. It is made by the National Steam Economizer Company, of Springfield, Mass., and is claimed to utilize exhaust steam for water-heating purposes, condense it, eliminate all the oil and sediment from the water of condensation and return it to the boiler at 212° Fahr., and at the same time furnish heat to an air blast for heating and drying purposes. The construction is clearly shown in the engraving. There is an upper chamber, in which is located the superheating coil, a middle chamber with the condensing and hot-air pipes, and a settling chamber with projecting and suspended baffle plates for taking out the oil. The exhaust entering, passes over the superheating pipes, thence over the cold-air tubes, impinges upon one set of baffle plates, passes around them and is sprayed from a pipe over another set of baffle plates under the tubes. By means of a blower a blast of cold air is forced through the tubes, condensing the steam and consequently absorbing heat. The condensation, mingled with the feed water, passes to the settling tank. In passing under the suspended plates and over the projecting plates into the pump chamber all the impurities are said to be removed and deposited in the bottom of the tank, and the water is cooled to about 200° Fahr., when the pump forces it through the heating coils to the boiler. This arrangement is said to eliminate not only the dirt and impurities, but also all of the oil. As the water line is above the suspended plates and as the narrow plates extend above the bottoms of these plates the oil, it is claimed, is held back and cannot enter the pump chamber, but is carried off by an overflow pipe. The hot air is said to leave the apparatus at a temperature of 160° to 170°, and aside from being used for heating purposes may be used for forced draft. Ample provision is made for cleaning the apparatus.

NEW SNAP SWITCH.

Pass & Seymour, Inc., of Solvay, N. Y., have recently placed on the market the new snap switch shown by Fig. 4, which they say is the result of two years' study and experiment. In consideration of the rough usage and frequent service usually sustained by a switch of this kind, it has been carefully designed and submitted to tests throughout the entire period of development; the weak points being remedied as fast as they appeared. The tests of the switch have been quite severe, they having been subjected to 50,000 makes and breaks at the rate of three per minute, while carrying 15 amperes at 220 volts. As the underwriter requirements do not permit more than 660 watts to be controlled by a single-pole switch,

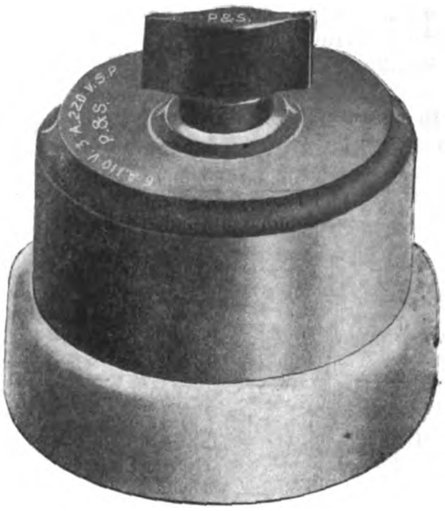


FIG. 4.—P. & S. SNAP SWITCH.

the switches are marked 3 amperes, 220 volts; 6 amperes, 110 volts; but they are warranted to carry from 10 to 15 amperes without heating. The switch is at present only made in the single-pole form, but a line of double-pole switches is in process of manufacture.

THE "STAR" LATHES.

Fig. 5 shows one of the latest types of "Star" foot-lathes made by the Seneca Falls Manufacturing Company, Seneca Falls, N. Y., which is admirably adapted for repair shops, experimental and model work, and all shops requiring such service. The lathes are made in varying sizes, ranging from 9-in. swing and 24 ins. between centers, up to 13-in. swing and 66 ins. between centers, and are mounted on curved legs, as shown, when furnished with foot power, and on straight legs for shop use with countershaft and an oil pan for tool room use. The head stock spindle is hollow, and made from a crucible steel forging; it runs in long phosphor bronze bearings and is also provided with an improved end thrust ball bearing. The tail stock is of an improved curved pattern, which allows compound rest to swing around parallel with the ways and over the base of the tail stock, with room to operate the feed screw handle. The tail stock spindle is arranged with self-discharging center and improved locking device, and an adjustable side movement is provided for turning tapers. The carriage has a long bearing on the ways, and is gibbed to the bed at both front and rear. Interchangeable plain and compound rests are provided, with graduated base for making fine adjustments, and an improved tool post collar and shoe exclude all dirt and chips and admit of a quick and secure adjustment of the tool.

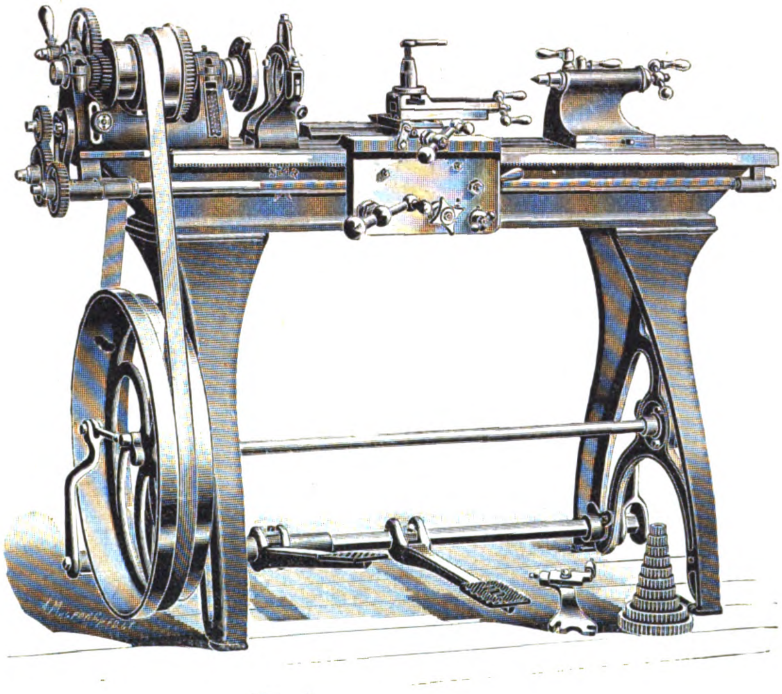


FIG. 5.—SENECA FALLS "STAR" LATHE.

The automatic cross and longitudinal feeds are actuated by a phosphor bronze worm on the lead screw, which is splined and for all work except screw cutting simply acts as a feed rod and, therefore, the only wear on its threads is in screw cutting. The feed may be thrown in or out of contact by simply moving a lever, and will feed in or out, right or left, and cut screws right or left. All standard threads from 3 to 64 can be cut without compounding the gears, and nearly all threads by compounding them. The patent foot power consists of two treadles attached as shown, and when desired a friction countershaft is furnished in place of the foot power. Each lathe is provided with a center rest, follower rest, point centers, full set of change gears and necessary wrenches. Blocking, taper attachment, draw-in chuck attachment, gear cutting and milling attachments are furnished extra. Each attachment is said to be thoroughly practical and accurate, and invaluable to a shop not having a complete equipment of machine tools.

"BATTERY BLACK" INSULATING PAINT.

There are many insulating paints and compounds which are most efficient for a limited length of time after their application but which deteriorate rapidly later on, so that frequent renewals are necessary in order to prevent the possibility of serious accidents due to the breaking down of insulation where the paint is relied upon. There are, of course, many places in which the renewal of a paint is impossible, such as on armature coils and the inner layers of field magnet or other high potential coils, and for such use it is indispensable that the insulating paint used shall retain its insulating property for a long time, certainly as long as the probable life of the coil to which it is applied. An insulating paint, known as "Battery Black," prepared with a view to fulfilling this condition, is manufactured by James G. Conner & Co., of Philadelphia, Pa. It is claimed that this paint preserves its insulating property for a relatively long period of time, and that it is unaffected by acid fumes or similar influences, so that it is not only applicable to armature and field-magnet service, but should be useful in storage battery installations.

MEDICAL INDUCTION COIL OUTFIT.

Fig. 6, herewith, illustrates a compact induction coil outfit for electro-medical purposes, comprising an induction coil with the usual electrodes, a cell of Mesco dry battery, and a box containing the whole equipment. A feature of the induction coil is that the vibrator is mounted on the head of the coil instead of on the baseboard to which the coil is secured. This arrangement, while very simple, is said to give a much more reliable vibrator than the ordinary style mounted separately on the wooden base, as there is no liability to the loosening of screws by wood shrinkage. A clip is provided on the inside of the box lid for holding the hand electrodes, sponge electrodes and conducting cords when the box is closed. The strength of the coil is adjusted in the usual manner by sliding a brass tube (forming a closed secondary) in and out of the coil. The outfit is extremely compact, the box measuring 7½ ins. in length, 3½ ins. in width and 5¼ ins. in height when closed. This little outfit is known as the "Anti-Doc No. 6" medical apparatus, and is manufactured by the Manhattan Electrical Supply Company, New York.

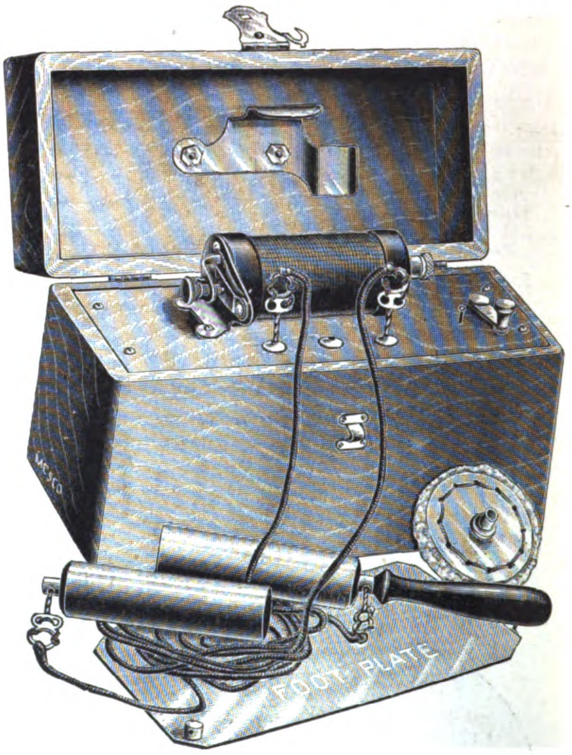


FIG. 6.—MEDICAL INDUCTION COIL OUTFIT.

PERFECTION STEAM CLAMP.

A clamp, which is guaranteed to effectually stop any leak at an elbow, tee, flange, valve or fitting on any pipe is shown in Fig. 7. It is known as the "Perfection" steam clamp, and is manufactured by F. A. Nusbaum, of Dayton, Ohio. The rings are made of brass in sizes from 3 to 20 ins. in diameter and have a soft packing ring between them, which fits in a recess in the gland ring. The clamp forms a joint precisely as a flange joint, the soft packing ring being forced around the leak and a surplus of packing is forced under the bottom ring between the ring and the fitting, and also inside of the ring and the pipe, thus making practically a flange joint. In a test made, these clamps stopped leaks under a pressure of 150 lbs. through ⅛-in. holes drilled around a steam pipe. The clamp is shown in position in Fig. 8. It is especially useful in temporarily stopping a leak, when a plant is in operation, until such time as repairs can be conveniently made, but can be left on permanently, of course, if desired. It can be attached in a few minute and can be covered with lagging the same as a pipe.

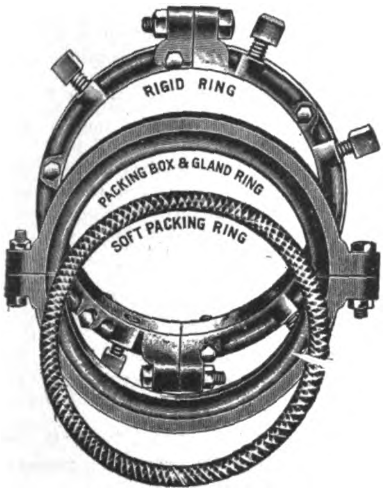


FIG. 7.—PERFECTION STEAM CLAMP.

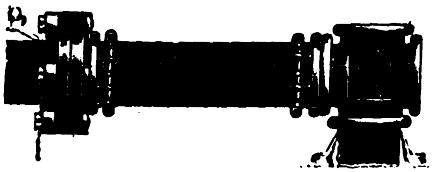


FIG. 8.—CLAMP APPLIED.

LAUNCH MOTORS.

In the accompanying illustration is shown a half horse-power motor, which is one of a line built by the Holtzer-Cabot Electric Company, of Boston, especially for launch work. As will be observed, the motor is entirely enclosed, being practically moisture proof. If the motor is well protected or is to be used in fresh water, the weight is materially decreased by the use of aluminum in parts where other metals are not necessary for electrical or magnetic purposes; although, if the motor is likely to be exposed to the salt water, brass or iron fittings are recommended because of the corrosive action of the salt water upon the aluminum. In the latter case the finished parts of the machine are copper plated for the same reason. The shape of the frame is such that two equal paths are provided for the magnetic flux, one on either side of the armature. As the voltage is low the current is necessarily proportionately high, making the design of the brush holder a feature of great importance.

The brush holder provided on these motors is of the box type, with parallel feed, making it possible to run the motor for a long period of time without any attention to the brushes. A special form of brush is used, consisting of stratifications of woven copper gauze and carbon, the outside layers being of the latter substance backed by heavy copper plates. A continuous metallic circuit is maintained between the brush and the holder, so that no sliding or imperfect contacts are required to carry current. This is said to make an efficient and satisfactory brush arrangement for work of this kind, allowing long wear with minimum attention, and making heat losses due to the flow of the current insignificant.

The machines are very economical in operation. The speed is low, 1000 r.p.m., and as they are series wound, they use field energy only in proportion to the load, thus modifying two of the most important sources of waste; namely, friction and heat losses in the windings. The voltage is usually low, from 20 to 40 being ample in most cases, so that there is no possible chance of injury to the operator. The motor is usually supported in the stern of the boat by means of heavy braces, which are bolted to the body of the motor.

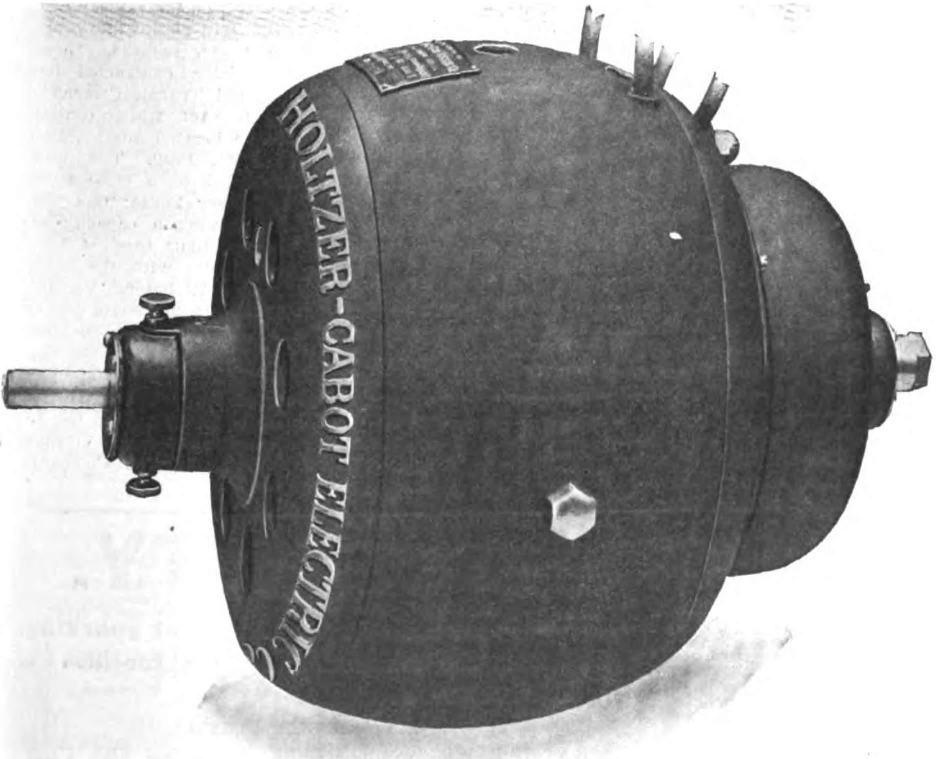


FIG. 9.—½-H.-P. HOLZER-CABOT LAUNCH MOTOR.

NEW BOOKS.

Principles of Physics. By Frank M. Gilley. Boston: Allyn & Bacon. Cloth; 552 + viii pages, 5 x 7½ ins.; 498 illustrations. Price, $1.30.

This is a text-book of the usual character used in high schools, except that it is considerably more intelligible than the majority of its class. It will be found of service by any student whose knowledge of fundamental principles requires strengthening.

Electric Power Transmission. By Louis Bell, Ph. D. (Third Edition). New York: Electrical World and Engineer (Inc.). Cloth; 640 pages, 6 x 9½ ins.; 306 illustrations, including 21 full-page plates. Price, $3.

The present edition of this book contains a great deal of new matter, and the material that appeared in the former edition has been considerably revised. The chapter on General Conditions of Power Transmission has been enlarged from 47 to 54 pages; the discussion of synchronous and induction motors has been elaborated sufficiently to form a separate chapter of 59 pages; that relating to prime movers has been divided into two chapters, one on engines and boilers and the other on water wheels, and a chapter on the electrical measurement of energy has been added. The book contains few inaccurate statements—notably one on page 224: "The polyphase synchronous motor will run * * * if one of the leads be broken, as a monophase machine"; and on page 534: "Fig. 251 * * * is about the same in effect as the three-phase system with a neutral having but two branches instead of three to balance," but these are relatively unimportant. The figure of merit of the book as a whole is extremely high.

LEGAL NOTE.

THE BRUSH STORAGE BATTERY PATENT.—Judge Lacombe, sitting in the United States Circuit Court for the Southern District of New York, has issued an injunction restraining the Porter Battery Company from the manufacture of battery elements or electrodes infringing the historical patent of Charles F. Brush, which is owned by the Electric Storage Battery Company, of Philadelphia, Pa.

PERSONAL.

MR. ANSON W. BURCHARD, a consulting engineer of the General Electric Company, has been elected second vice-president of the Greene Consolidated Copper Company.

MR. C. E. YOUNG has been appointed advertising manager for the Western Electric Company, Chicago, Ill., and Mr. Frank Ketcham, who previously held this position, has been promoted to the superintendency of the stock department.

MR. W. R. BRIXEY, the well-known manufacturer of Kerite wires and cables, who was severely injured by the recent dynamite explosion near the Murray Hill Hotel, New York, is rapidly improving, and it is expected that he will be able to leave the hospital within the next week or so.

MR. CHARLES McC. CHAMPMAN has engaged in the practice of patent law, with headquarters in the Nassau-Beekman Building, New York City. Mr. Chapman was for twelve years an examiner in the United States Patent Office, so that he is unusually well equipped for the line of work which he has now undertaken.

MR. ARTHUR HARTWELL, who until recently was manager of the Chicago office of the Westinghouse Electric & Manufacturing Company, has been advanced to the position of sales manager, in charge of the entire sales organization.

MR. PHILIP A. LANGE, previously general superintendent, has been made manager of works, having entire charge of the manufacturing department of the company.

MR. THOMAS L. TOWNSEND, for many years connected with Partrick, Carter & Wilkins Company, Philadelphia, Pa., has resigned his position with that company to accept the general managership of the Vallee Brothers Electrical Company, Philadelphia. It is neither flattery nor exaggeration to say that Mr. Townsend is undoubtedly one of the best-known, best-liked and most successful electrical salesmen in the entire general field, and it is with extreme and justified regret that his old firm releases him.

MR. C. O. MAILLOUX, the well-known consulting electrical engineer, has just left New York for a Western trip, and will spend considerable time in Arizona, where he has charge of some extremely important work.

MR. GEORGE A. WADDELL has been appointed chief electrician of the Merchants & Miners' Transportation Company, Baltimore, Md. Mr. Waddell is a student of the American School of Correspondence, Boston, Mass., and is a shining example of the type of successful self-made men which institutions of this class are doing so much to bring forward.

TRADE PUBLICATIONS.

SMITH-VAILE POWER PUMPING MACHINERY. The Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio.—This is Catalogue No. 40, devoted principally to the well-known Smith-Vaile pumps adapted to be driven by belt, motor or other extraneous power. The catalogue is finely executed, containing half-tone illustrations of the very comprehensive lines of pumps, together with descriptive and statistical matter. Part of the catalogue is devoted to combined jet condensers and vacuum pumps, heavy-duty pumping engines and Stilwell feed-water heaters and purifiers.

WATER-WHEEL GOVERNORS. Sturgess Governor Engineering Company, Troy, N. Y.—A handsomely-executed catalogue containing illustrations and descriptive matter relating to the Sturgess water wheel governor, which is of the hydraulic type; that is to say, the work of moving the gate is performed by a hydraulic cylinder and piston. A notable feature of the governor is the arrangement of the relay, by which the centrifugal governing device is restored to its normal speed a trifle in advance of the water wheel, so as to counteract over-running or serious lag in speed rectification.

ELECTROMAGNETS AND WINDINGS. The Varley Duplex Magnet Company, Phillipsdale, R. I.—An illustrated catalogue containing descriptions and prices of magnets, induction coils, and solenoids, made by the Varley patent process, and wound on automatic machinery. The solenoids are made of any length from ⅞ in. to 4 ins., on paper or fiber tubes, and to slip freely over cores of from ¼ in. to 2 ins. in diameter. Magnets for telephone call bells, annunciator drops and similar apparatus are also included in the list, as well as induction coils, medical coils, gas-lighting spark coils, and resistance coils.

CALENDAR.—Rossiter, MacGovern & Co., New York.—This is an ornamental card and pad calendar in which the ornamental feature largely predominates. The calendar pad is of very modest size and occupies a subordinate position on the card. The latter bears a picture, executed in colors, representing an attractive young woman attired in the latest fashion and holding aloft an electric car headlight, in the excitement of which performance she inadvertently exposes a goodly length of red hose.

WATER-WHEEL GOVERNORS. The Lombard Governor Company, Boston, Mass.—The 1902 catalogue of the Lombard Company, in which is described in full detail the construction and operation of its widely-used water-wheel governor. This governor is built for every practical class of service, and a modification of it is also built for the speed control of steam engines. The catalogue contains a great many testimonial letters which are highly commendatory of the apparatus.

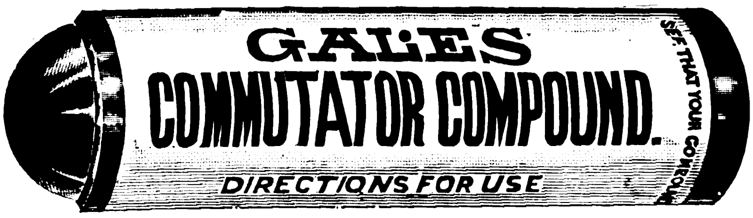
BUSINESS NEWS.

THE LIBERTY MANUFACTURING COMPANY, Pittsburg, Pa., reports a tremendous increase in the sales of "turbine" boiler-tube cleaners. One jobber has just placed an order for 500 cleaners to be taken during the present year.

THE SPRAGUE ELECTRIC COMPANY, New York, recently received an order from the Atlas Portland Cement Company for three 400-kw. engine-type split-pole generators, to run at 156 r.p.m., for the Atlas plant at Hannibal, Mo.; an order from the De Laval Steam Turbine Company for ten 20-kw. and ten 75-kw. turbine generators, and the Pennsylvania Steel Company has ordered for its new bridge shop at Steelton, Pa., fifteen wall crane trolley hoists, the electric hoisting equipment of which is to be built by the Sprague Company.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., is actively engaged in preparing and installing a large number of storage batteries for railway and lighting service, which will be put into operation within the next few months. Three large batteries have been contracted for by the Twin City Rapid Transit Company, Minneapolis, Minn., two of which consist of 288 cells each, to be located one at Minneapolis and one at St. Paul. The third battery will be installed in a sub-station 7½ miles from the power house; this will consist of 315 cells, having a capacity of 400 kilowatts at the one-hour rate. A contract has also been made with the West Hampton Park Railway, Richmond, Va., for a 250-cell battery of 480 ampere-hours capacity. Other large batteries will be installed in the plants of the St. Albans (Vt.) Railway Company, Indianapolis & Eastern Traction Company, San Juan & Santa Clara Railroad Company at San Jose, Cal., Trenton (N. J.) Street Railway Company, and the Virginia Electric Railway & Equipment Company, Richmond, Va.

A COMMUTATOR NECESSITY.



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VARLEY DUPLEX MAGNET COMPANY, Phillipsdale, R. I., announces that the American Electrical Works, Providence, R. I., has been appointed general sales agent throughout the United States for Varley magnet windings.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has just perfected a complete line of drum controllers for printing-press, crane, hoisting, machine-tool, and similar motors. These controllers are built in several forms, one of which provides speed control by altering both the armature and field-magnet circuits, and also embodies no-voltage and over-load automatic release.

JAS. L. ROBERTSON & SONS, New York, are distributing an attractive little dice box made entirely of celluloid, with a transparent cover. One of these souvenirs will be sent to any address upon receipt of six cents in stamps to cover the expense of transportation.

WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., announces that the demand for its new Wesco dry battery has become so great as to render it difficult to fill orders promptly. It is claimed that this battery shows an unusually rapid recuperation and long life.

COMMERCIAL ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is meeting with most gratifying success in the sale of the Hydra battery cell, for which it is selling agent in the South and Southwest. This battery contains a sealed carbon cylinder in which is a zinc cylinder embedded in a moist electrolytic paste of a patented composition. The carbon cylinder is surrounded by a depolarizing paste which is subsequently dried out. It is claimed that instead of running down rapidly, like an ordinary dry battery, the Hydra cell recuperates while it is in service.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, has opened a branch office in the Keystone Telephone Building, corner of Second and Sansom Streets, Philadelphia, Pa., where a full line of sample instruments will be on exhibition. The office is under the supervision of Paul W. Bossart, manager of the company's Eastern district. The company has just closed a contract with the Renesselaer Telephone Company, Troy, N. Y., for one of its Major relay-type switchboards of 3000 lines capacity, with a present capacity of 1500 lines; all necessary power apparatus, chief operator's desk, wire chief's desk, and a tollboard of 100 lines capacity, with present equipment of 40 lines. A contract has been closed also with the Cass County Telephone Construction Company, of South Bend, Ind., for a central energy Major relay-type switchboard of 4000 lines capacity, with a possibility of 7200 lines; all necessary power apparatus, arresters, frames, etc.; 100 standard central-energy telephones, and a tollboard of 50 lines capacity, with a present equipment of 25 lines. The company intends making this one of the most important toll lines in the West, giving service direct from Chicago to New York.

GARTON-DANIELS COMPANY, Keokuk, Iowa, reports a steadily increasing demand for its auxiliary bell ringers for use in connection with telephone call bells.

THE PELTON WATER WHEEL COMPANY, San Francisco and New York, reports a large number of orders and a marked increase of business for the present year. Among the apparatus recently shipped and in process of construction may be mentioned the following: Wheels for driving four 500-kw. units for an electrical transmission plant in Colorado; two 600-h.p. plants for electric transmission in central California; a 500-h.p. wheel for an electric lighting plant in Lundy, Cal.; three units, each of 300 horse-power, for an electric power transmission company in the Hawaiian Islands; one 1600-h.p. wheel for an electric transmission plant in Colorado; three wheels for driving 1000-kw. generators for electric transmission in northern California; a 1000-h.p. unit driving an electric-railway generator in Santa Cruz, Cal. (second unit); wheel for a 1500-h.p. electric transmission plant in Tuolumne County, Cal. (second unit); wheel for driving a 1000-kw. generator for a mine and transmission plant in Calaveras County, Cal. (second unit), and four units, each of 550 horse-power, for an electric transmission plant in southern Cali-

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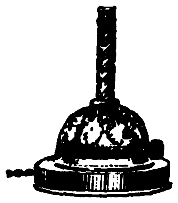
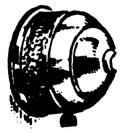

No. 2.
Base of Portable.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Where outlet
box is used.

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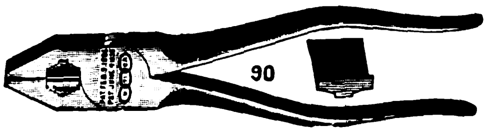

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has no equal for strength and uniformity. Made with the most exacting care for use as music wire, it is adapted for use in electrical work where an absolutely perfect wire is indispensable. Ask for circular No. 149W.

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fornia. This company also advises that its foreign trade, especially in wheels for driving electrical apparatus, has vastly increased during the past year, indicating a growing appreciation of American machinery on the part of foreign engineers.

REYNOLDS ELECTRIC COMPANY, Chicago, Ill., announces that recent improvements have been made in the Reynolds flasher manufactured by this company which have simplified the apparatus to the last degree, and rendered it practically perfect in the matter of reliability and durability.

CHASE-SHAWMUT COMPANY, Boston, Mass., suffered a serious hindrance in the shape of a fire in its factory late in January, but the company promptly secured new and commodious quarters, and the factory is now in full operation, turning out the usual lines of fuse wire, fuse links, enclosed fuses, rail bonds, junction boxes, etc., with old-time promptness.

AMERICAN TRADING COMPANY, New York, is the new style of the concern which was for many years known as Flint, Eddy & Co., and more recently as Flint, Eddy & American Trading Company. The management of the company will be in the same hands which have made it so successful in the past, and the company will continue the same general export and import business as heretofore with the principal foreign countries.

STUART-HOWLAND COMPANY, Boston, Mass., reports that its sales for 1901 show an increase of 120 per cent over the sales of the previous year. The company has been particularly successful in its department of street railway supplies and specialties, having furnished during the past year the entire overhead and pole equipment, excepting the wire, for over 500 miles of new railway. The company carries a very complete stock of all kinds of electrical supplies, and has ten salesmen constantly on the road.

RECEIVER'S NOTICE.—Norman McD. Crawford has issued a notice to the creditors of the Eddy Electric Manufacturing Company, Windsor, Conn., announcing his appointment as temporary receiver of the assets and effects of that company on February 8.

SILLS-EDDY MICA COMPANY has removed its general office from the factory at Newark, N. J., to the Broad Exchange Building, New York. In addition to its large mica trade this company manufactures micabeston and Imperial insulating material.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, New York, has extended its quarters all the way through the building which it occupies on Cortlandt Street, so that the store now has an entrance on Dey Street, and has about double the former amount of space. The company also made a large increase in its factory capacity recently, and it is confidently expected that the double enlargement will enable it to take care promptly of its rapidly increasing orders, which had hitherto been rather congested.

WESTINGHOUSE, CHURCH, KERR & CO., New York, report the receipt recently of orders for two 1000-kw. Westinghouse-Parsons turbine-generator sets for the De Beers Consolidated Mines, Ltd., in South Africa. The company also reports a continued flourishing trade in Roney mechanical stokers. Among orders recently received for complete equipments were the following: The Lebanon (Pa.) plant of the Lackawanna Iron & Steel Company; power plant of W. W. Dunnell, Appinong, R. I., and the power plant of the Standard Steel Car Company at Pittsburg, Pa. The order received from the Lackawanna Iron & Steel Company carries the aggregate of the equipments thus far furnished that company up to 8500 horsepower.

THE LAGONDA MANUFACTURING COMPANY, Springfield, Ohio, recently received the following significant letter concerning its well-known Weinland boiler-tube cleaner:

> "I have given the cleaner which you sent us a trial and find it very satisfactory. I have used 160 lbs. pressure, and have averaged about ten tubes an hour. It is very economical in water consumption, and I am entirely satisfied with it.
>
> "(Signed) J. B. ARMACK,
> "Engineer, Union Depot Company, Colum-
> "bus, Ohio."

THE HAINES & NOYES COMPANY, Chicago, Ill., for the purpose of introducing its hand microphone to the trade, is making a special offer on this instrument. The instrument is of the familiar type, having a non-packing transmitter and a bipolar pony watch receiver mounted on a single handle, which is provided with a hard-rubber grip. The contacts are inside the handle, as usual, and all the metal parts are heavily nickel-plated. The hard-rubber shell of the telephone receiver is water shrunk and the receiver is permanently adjusted. The outfit is furnished with an extra long cord for convenience in office use.

I. P. FRINK, New York, reports among recent prominent stores which have adopted his well-known system of show-window reflectors the following: Eastman Bros. & Bancroft, Portland, Me.; Edward Malley & Co., New Haven, Conn.; Kauffman, Strauss & Co., Lexington, Ky.; Burke & Co., Norfolk, Va.; Geo. Muse, Atlanta, Ga.; Parker Lowe Dry Goods Company, Ft. Worth, Texas, and W. R. Bennett Company, Omaha, Neb. Burke & Co. also recently installed this system in their Dallas (Texas), Richmond (Va.) and Memphis and Nashville (Tenn.) stores. The New York store of Kaskel & Kaskel has also been equipped with the Frink show-window reflectors and the show-case system, and modifications of these have been installed by H. C. F. Koch & Co., New York, and the Callender, McAuslan & Troup Company, Providence, R. I.

....BOOKS....

WATSON.—How to Run Engines and Boilers. 5th edition; cloth $1.00
TENNANT.—The Slide Valve Simply Explained. Cloth 1.00
HENTHORN.—The Corliss Engine and Its Management. 4th edition 1.00
DAHLSTROM.—The Fireman's Guide to Care of Boilers. 8th edition .... .50
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The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

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American Electrician.

Vol. XIV. New York, April, 1902. No. 4.

A MODERN CENTRAL ENERGY BELL TELEPHONE EXCHANGE.

THE NEW COMMON BATTERY EXCHANGE AT MT. VERNON, N. Y.

During the past four years there has been brought about almost without attracting attention a complete transformation of the plant of the New York Telephone Company on Manhattan Island. Beginning in 1898, with the Harlem central office, the company has transformed its then existing plant to the common battery plan, carrying out the change at the rate of one new central office every three months. At the same time the company has taken care of an enormous increase in subscribers, the number having increased from 25,000 stations in 1898 to 73,000 stations at the present time. So effectively was this change brought about that not only did the service not suffer, as it might well have been expected to do, but on the contrary, with each successive step an improvement was noted.

To get the full benefits of the common battery system, however, in such a network as that of New York, which is the most extensive in the world, it is not only necessary that all of the offices within the city proper should be of an interlocking type, but it is also necessary that even those offices of moderate size in the suburbs shall be of equally up-to-date construction.

Having completed its work of changing on Manhattan Island, the telephone company has carried the work on into the Borough of the Bronx, where within a few months a large common battery center will be established at Melrose. In addition to this extensive modern improvements have been planned for Westchester County, and common battery installations have been scheduled for Yonkers, Mount Vernon and New Rochelle. The present article gives a description of some interesting features of the common battery switchboard which has just been completed in the city of Mount Vernon.

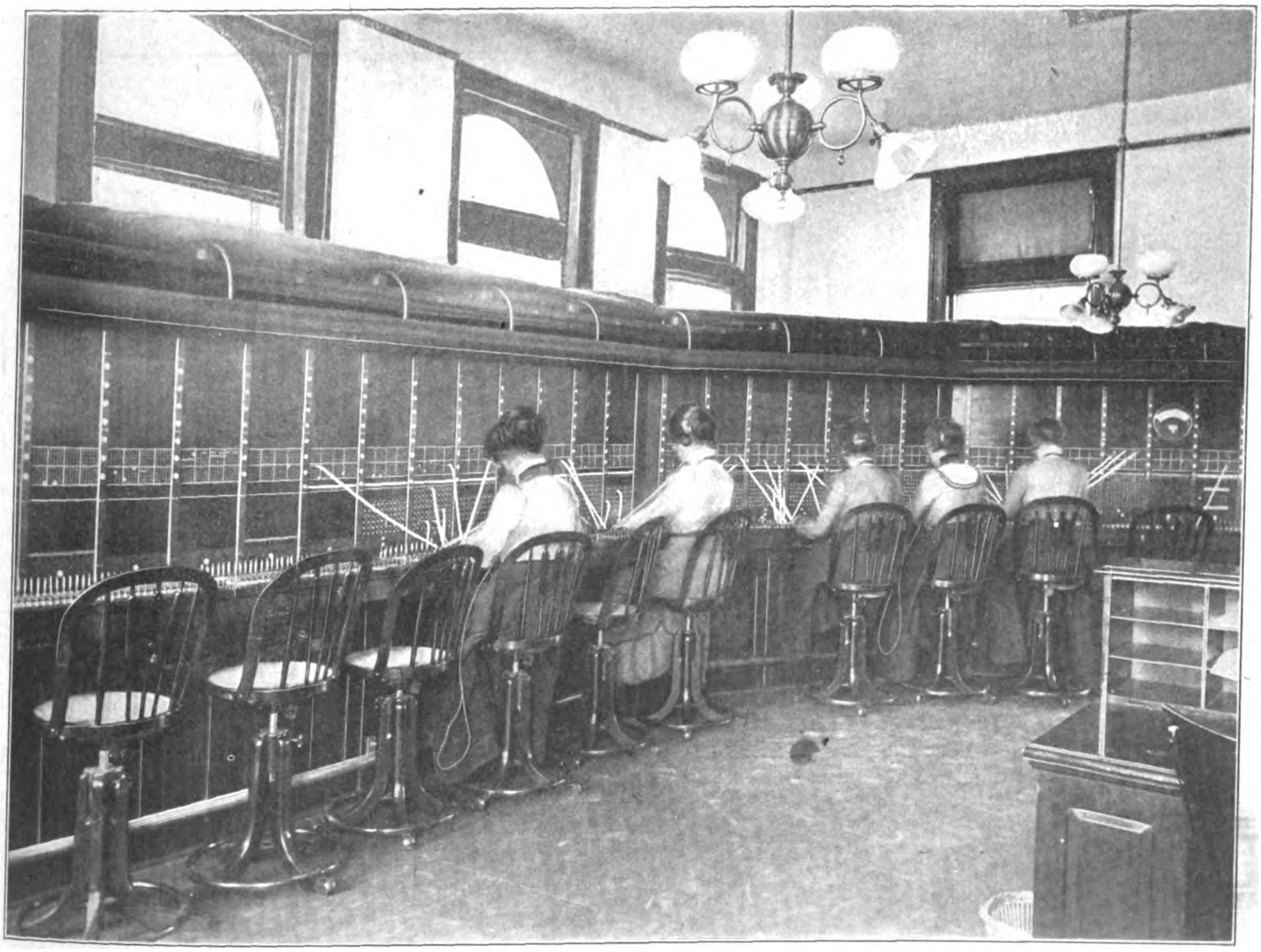

FIG. 1.—SWITCHBOARD OF THE NEW YORK TELEPHONE COMPANY'S EXCHANGE AT MT. VERNON, N. Y.

This switchboard is located in a four-story fire-proof building; not all of the building is required for the switchboard plant, of course, much of the space being occupied by the construction, maintenance and other departments, this office being the headquarters for a considerable part of the surrounding country. In Fig. 1 is shown a corner of the switchboard room, with a few operators at work at the switchboard. This switchboard is of the standard type used in the New York City exchange offices, but is, of course, not built on such a large scale. The equipment in the board at present is for 1000 lines and about 170 trunk lines; provision has been made for an increase ultimately to 3500 subscribers' lines, and double the present trunk equipment. The circuits in the board are of the standard type, which has been described several times in previous articles.

There are two features brought out in the picture which are interesting and usually escape notice. The first is the pipe-like structure supported by curved brackets from the top of the switchboard. This is really a reflector, under which are located a number of incandescent lamps for distributing light over the face of the board and shading the operators' eyes. Inasmuch as signals are received by the lighting and extinguishing of small lamps, it is important that too great a degree of brilliancy in illumination should not be attained, while on the other hand, sufficient light must be provided in order that the operators may be able to quickly select any one of the small jacks when working at the board at night. In the Mount Vernon board the reflector employed, and shown in the picture, accomplishes the result admirably.

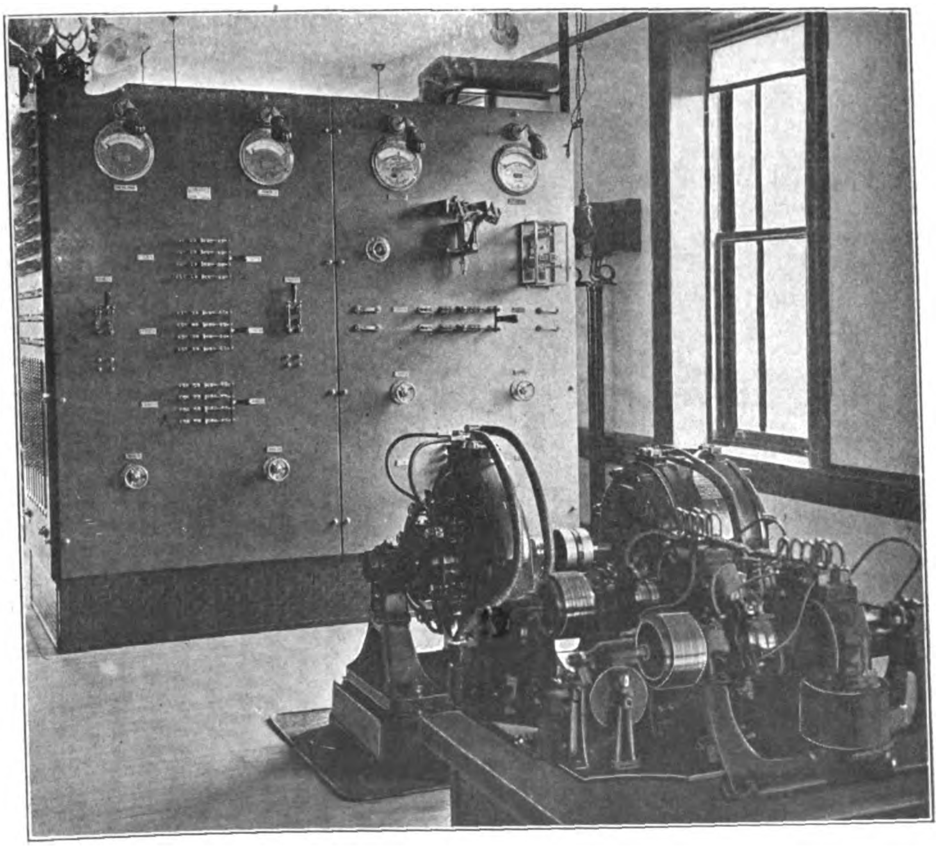

FIG. 2.—POWER SWITCHBOARD, GENERATING AND RINGING EQUIPMENT.

The other feature referred to is the bundle of cloth which appears to be furled up and laid along the top of the board. This is a tarpaulin so arranged that it can be quickly let down over the reflector to cover the entire front of the board. It is so constructed that part of it will at the same time fall over the rear of the board and cover that up also. This is for use in case of fire, to protect the switchboard from the firemen's hose, which, in a telephone exchange, is about as much to be dreaded as the devouring element itself. In this exchange, as well as all others in the company's system, a fire drill is practised, and the tarpaulin let down at regular intervals, so as to make sure that it will be ready and properly handled in case of necessity.

In Fig. 2 is shown a view of part of the power switchboard and generating machinery. The primary source of current for operating this exchange is a two-phase, 208-volt, 60-cycle, alternating current motor which is direct connected by a flexible insulated coupling to a direct-current dynamo capable of delivering 150 amperes at 25 volts. Bridged across the mains of this generator, to which are also connected through proper fuses the various telephone circuits, is a storage battery of 40,000 watt-hours capacity. As an auxiliary power service, there is installed in the basement a 10-h.p. gas engine, belted to a generator having the same output as the one just mentioned. To the storage battery is also connected the ringing machines in duplicate, which furnish the current for ringing, and also through commutators and worm gears, shown at the left of the machines in the foreground, for giving signals to the operators in this and other exchanges to tell them when lines are busy or out of order. These machines are controlled by the usual switches, rheostats, circuit-breakers and meters, located on the slate switchboard, shown in the engraving.

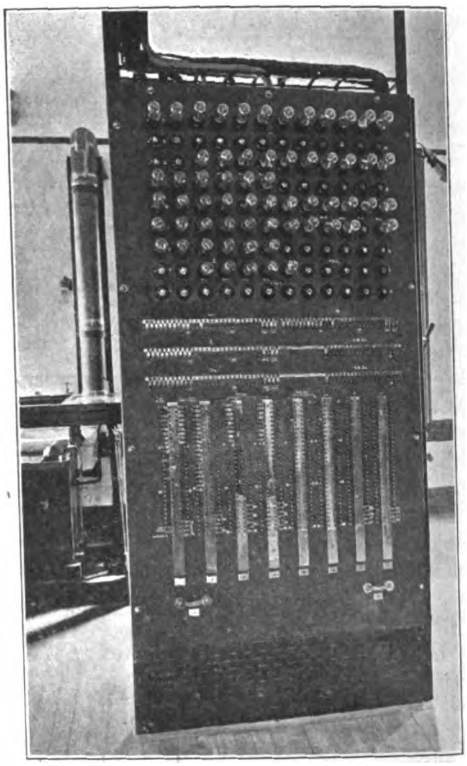

FIG. 3.—FUSE BOARD FOR RINGING CIRCUITS.

Fig. 3 is a view of the slate fuse board with the resistance lamps, which may be seen also at the extreme left of Fig. 2. The function of the lamp is to furnish a resistance which can under no circumstances become itself a fire risk, and which under all circumstances will prevent the ringing current from exceeding a safe limit. In addition to these resistance lamps, there is a carefully-adjusted system of fuses, which are shown on the board at the bottom. This protective system is for the signaling circuits only, the usual protecting devices being employed for outgoing lines. To the left of the fuse and lamp-board one end of the storage battery plant appears, with a ventilating pipe connecting to the open air.

Fig. 4 gives an unusually good view of the rear of the switchboard, showing one of the sections completely. At the bottom of the picture appear the answering jack cables, connecting the answering jacks and line signals in the switchboard to the subscribers' lines through the intermediate and main distributing frames. Above these are the repeating coil cables, through which the talking and signalling current is supplied to the pairs of cords and "incoming-trunk" cords. In this wiring is also the order-circuit cabling, connecting the order-circuit buttons together, which circuits are used for ordering trunk connections at distant exchanges. Above this wiring are the resistance coils and supervisory relays in the pairs of connecting cords. The cords themselves are shown above the relays, and are knotted up in apparently a disordered manner, but there is method in this disorder, this knotting up being a handy way of disposing of slack in the cords, which is taken out as fast as they break off, and are repaired at the plugs. Above these cords are the answering jack and line signal wiring, the outgoing-trunk cables and subscribers' cables. The rear of the board is enclosed and protected from dust by a very ingenious roll-up curtain similar to that used on roll-top desks. This curtain is rolled up in position to expose the wiring, in the picture.

In Fig. 5 is given a view of the main distributing frame, intermediate distributing frame, and relay rack. The underground cables terminate on one side of the main distributing frame, on which are located the lightning arresters and heat coils. From the other side of the main distributing frame, cables extend to one side of intermediate distributing frame, and from this side of the intermediate distributing frame cables extend to tne multiple jacks in the switchboard. From the opposite side of the intermediate distributing frame, cables extend to the answering jacks and line signals, and also to the relay rack, on which are located the relays which control these signals. These relays are of two kinds: One which operates the signal when the subscriber calls and the other which cuts off all unnecessary apparatus from the talking circuit while the subscribers are talking. These distributing frames enable any wire in the underground cables to be connected to any line in the switchboard, and also enable any answering jack to be connected to any switchboard line, in the now well-known manner.

This installation at Mount Vernon, taken altogether, represents the latest and best practice, some features of which have been mentioned, but others of which will be readily perceived from the illustrations. It may be regarded as significant of the high state to which telephony has attained in the neighborhood of New York, that in such a small city as Mount Vernon such complete telephonic facilities are provided.

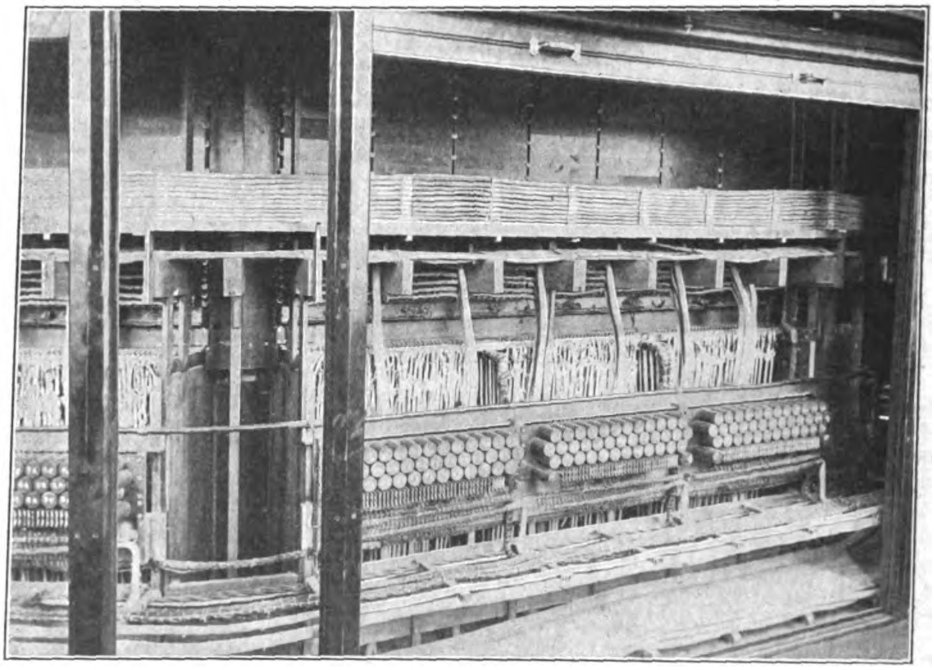

FIG. 4.—REAR VIEW OF TELEPHONE SWITCHBOARD.

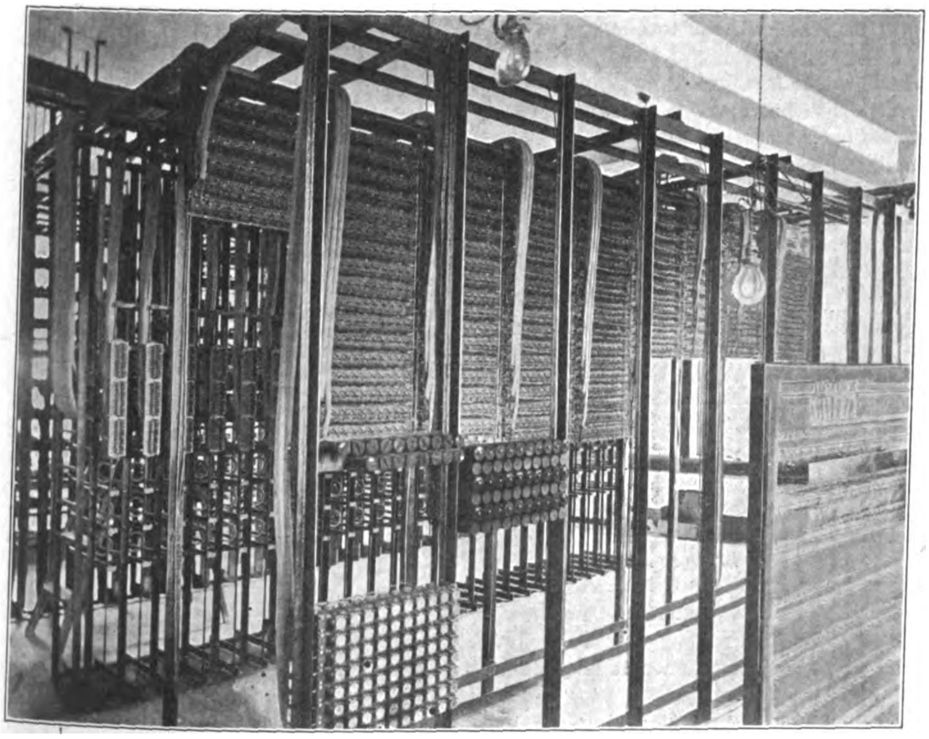

FIG. 5.—MAIN DISTRIBUTING FRAME, INTERMEDIATE DISTRIBUTING FRAME AND RELAY RACK.

CHARACTERISTIC PERFORMANCE OF THE INDUCTION MOTOR.

BY A. S. M'ALLISTER.

The analytical theory of the actions and reactions of induction motors nas been so frequently and thoroughly treated, both in text books and in current literature, that its repetition here would be superfluous. A few statements concerning the characteristic behavior of the induction motor, as built at present, may, however, be of interest. The machine that will be discussed here is the ordinary polyphase induction motor, having a stationary primary wound witn overlapping coils in slots, and a revolving secondary which moves in the rotating field set up by the primary windings. As is well known, the speed of the secondary can never equal the speed of the rotating magnetic field, because the conductors of the secondary must cut the lines of force of the field in order to cause current to flow in the secondary winding, and pull the rotor around; if the speeds were identical there would be no cutting. The difference between these two speeds is commonly known as "slip." For the purpose of this discussion the slip will be considered in terms of the synchronous speed, that is to say, if the synchronous speed were 1200 r.p.m. and the actual speed of the rotor or secondary member were 1176 r.p.m. and the slip would be $24 \div 1200 = 0.02$.

Since the conductors of the rotor cut an alternating field, first of one polarity and then of the other, the current induced in them will be alternating. The frequency of this current, as has often been explained by other writers, is normally much lower than the frequency of the supply current; the secondary frequency is equal to $s\ n$, s being the slip and n the frequency. The current in the secondary being alternating, the impedance of the secondary winding has a reactive component in addition to its resistance. The reactance at standstill is, of course, equal to

$$2 \pi n L = X.$$

n being the frequency of the supply current and *L* the coefficient of self-induction of the rotor winding. The secondary reactance when the machine is in operation is equal to

$$2 \pi n L s = s X,$$

s being the slip, as previously explained.

It is evident that the reactance of the secondary increases directly with the slip, so that with a constant value of secondary resistance the impedance increases as the slip increases; not in direct proportion, however. The effect of the reactive component of the secondary impedance is to cause the secondary current to lag behind the secondary e.m.f. by an "angle," the cosine of which is equal to the resistance of the circuit divided by its impedance. If θ represents this angle, cos ϕ represents the power factor of the secondary current.

Looking further into the effect of increasing the load on the motor, it will be plain that when the motor is running near synchronism the reactance is of negligible effect, so that the secondary current increases directly with the slip and has a power factor of practically unity. As the load increases, the torque must be greater; the motor slip therefore increases, with a consequent increase of secondary e.m.f. As the reactance begins now to increase, the impedance also increases, and the secondary current is no longer proportional directly to the secondary e.m.f., and the current which does flow has a power factor less than unity, requiring a proportionately larger current to produce a corresponding torque.

The increased draft of current demanded for the primary circuit entails a loss in the primary windings, and, since there must be mechanical clearance between the primary and secondary cores, the lines of force which pass from the primary to the secondary are diminished by the increase of the secondary current, which always flows so as to oppose the magnetism causing it. The magnetic field, therefore, which causes the secondary e.m.f. decreases with increase of load. In well-designed motors the decrease of magnetic field is slight. Since only the qualitative behavior of induction motors is necessary for the purpose of this discussion, and no regard need be had at present for the quantitative performance, this effect will be momentarily neglected.

Let E = secondary e.m.f. at standstill;

$s E$ = secondary e.m.f. at a slip s;

X = secondary reactance at standstill;

$s X$ = secondary reactance at a slip s;

R = secondary resistance.

then $\sqrt{R^2 + s^2 X^2}$ = secondary impedance,

$$I = \frac{s E}{\sqrt{R^2 + s^2 X^2}} = \text{secondary current, and}$$

$$\cos \theta = \frac{R}{\sqrt{R^2 + s^2 X^2}} = \text{secondary power}$$

factor; all three at the slip, *s*.

$$T = \frac{sE}{\sqrt{R^2 + s^2 X^2}} \times \frac{R}{\sqrt{R^2 + s^2 X^2}} \times K =$$

secondary torque, at the slip, *s*; where *K* is a constant depending upon the terms in which torque is expressed, and upon the magnetic field, assumed constant.

$$\text{Hence } T = \frac{R s E K}{R^2 + s^2 X^2} = \text{secondary torque}$$

at the slip *s*.

An examination of these formulas reveals many of the characteristics of the induction motor, which it is the purpose of this article to discuss.

(1) The torque becomes maximum when $R = s X$.

(2) If R be made equal to X, maximum torque will occur at standstill.

(3) Since at maximum torque $R = s X$, the torque is equal to

$$\frac{s^2 X E K}{2 s^2 X^2} = \frac{E K}{2 X},$$

and the value of maximum torque is independent of the resistance.

(4) When X is negligible the torque $= K \frac{s E}{R}$ or the torque is directly proportional to the slip near synchronism, and inversely to the resistance.

(5) At standstill the torque $= \frac{K R E}{R^2 + X^2}$, which, when R is less than X, can be increased by the insertion of resistance up to the point where the two are equal; further increase of resistance will then decrease the torque.

(6) The starting torque is proportional to the resistance and inversely proportional to the square of the impedance.

(7) Since power is proportional to the product of speed and torque, the output is equal to

$$P = A\ (1 - s)\ \frac{K R s E}{R^2 + s^2 X^2} = A\ (1 - s)\ T,$$

and is a maximum at a slip less than that giving maximum torque.

$$(8) \qquad I = \frac{sE}{\sqrt{R^2 + s^2 X^2}}$$

and at maximum torque $R^2 = s^2 X^2$. Therefore, I at maximum torque $= \frac{s E}{\sqrt{2}\, sX} = \frac{E}{\sqrt{2}\, X}$; whence it is plain that the secondary current giving maximum torque is independent of the secondary resistance.

(9) At maximum torque the secondary power factor $= \frac{1}{\sqrt{2}} = 0.707.$

$$(10) \qquad I^2 R = \frac{s^2 E^2 R}{R^2 + s^2 X^2} = \frac{s E T}{K}, \text{ and}$$

since E is constant for constant impressed pressure, the copper loss of the secondary is proportional to the product of the slip and torque.

(11) For a given torque the slip is proportional to the copper loss of the secondary and independent of the secondary reactance or coefficient of self-induction.

(12) Output is equal to $P = I E\ (1 - s)$ cos θ.

$$P = \frac{s E}{\sqrt{R^2 + s^2 X^2}} . E\ (1 - s) . \frac{R}{\sqrt{R^2 + s^2 X^2}} =$$

$$\frac{R s E^2\ (1 - s)}{R^2 + s^2 X^2} = \frac{T}{K} E\ (1 - s)$$

(13) If all losses except that of the secondary copper be neglected, the input will be

$$P + I^2 R = \frac{T}{K} E\ (1 - s) + \frac{T E s}{K}$$

and the efficiency will be

$$\frac{\frac{T}{K} E\ (1 - s)}{\frac{T}{K} E\ (1 - s) + \frac{T E s}{K}} = 1 - s.$$

which means that the efficiency is equal to the absolute speed in per cent of synchronism. Since there must be losses in addition to that of the secondary copper, the efficiency is always less than the speed in per cent of synchronism.

(14) At a given slip the torque varies as the square of the primary pressure. This is seen from the fact that the secondary current at a given slip will vary directly as the strength of field, the power factor will remain constant, and therefore the torque which is obtained from the product of secondary current, power factor and field will vary as the square of the field. Since the strength of the field varies directly with the primary pressure at a given slip, the torque will vary as the square of the primary pressure. Having thus determined the behavior of the induction motor under various changes of condition, the next step is to ascertain the methods by which it can be adapted to services of different requirements.

STARTING DEVICES FOR INDUCTION MOTORS.

If the impedance of the secondary be sufficiently great to prevent a destructive flow of current when full pressure is applied to the primary with the secondary at standstill, the motor may be started by being connected directly to the supply circuit. This is a method adopted quite extensively for motors of small size. If the impedance consists for the most part of reactance, the current drawn will have a low power factor, which, in general, affects materially the regulation of the system; the starting torque will be small.

It was proved above that by so proportioning the secondary resistance that $R = X$, the maximum torque would be exerted at standstill. With resistance of such a value permanently connected in the secondary circuit, at full load the slip would be enormous and the efficiency correspondingly low, as shown above. As a compromise in this respect, motors are usually constructed with only comparatively large resistance in the secondary windings.

In order to reduce the current at starting, large motors are often arranged to be supplied with a lower primary e.m.f. and the full line e.m.f. applied only after they have attained a fair speed. This is also especially desirable when otherwise the excessive starting torque would produce mechanical injury to the shafting, etc., driven by the motor. For elevators and cranes this method has found extensive application. Crane motors are built with a secondary resistance which gives maximum torque at standstill. The reduced primary pressure is secured either from lowering transformers or from compensators (auto-transformers). In either case, loops are taken to a suitable controller, by which the pressure supplied to the primary of the motor is governed. Pressures of a number of different values are thus obtained. The very intermittent character of the work performed by crane motors renders their low efficiency a necessary evil, since in any case the efficiency must be less than the speed in per cent of synchronism.

In order to combine large starting torque with good running speed and efficiency, it is customary to provide resistance external to the secondary windings and arrange to suitably reduce this resistance as the speed increases, allowing the motor to run without external resistance for the highest speed. For continuous service this method has proved highly satisfactory and gives the best running efficiency. Ordinarily, this necessitates the use of collector rings for the revolving member, whether such be the primary or the secondary. When the secondary revolves it is universally given a three-phase winding, independent of the number of phases of the primary, and therefore three collector rings are used. The external resistance is connected delta and regulated by a suitable controller.

A very ingenious device for automatically adjusting the external resistance was exhibited at the recent Paris Exposition. From the above it is plain that the frequency of the secondary e.m.f. depends directly upon the slip and is a maximum at standstill. If an induction coil of low resistance and high inductance be subjected to an e.m.f. of varying frequency, the admittance will vary inversely with the frequency. In the Fischer-Hinnen device, just referred to, there is connected external to the secondary windings a non-inductive resistance of a value to give practically maximum torque at standstill. In parallel with this is connected a highly inductive coil of extremely small resistance. At zero speed the admittance of the external impedance consists practically of only that of the non-inductive resistance. As the speed increases the admittance increases, due to the decreased reactance, and at synchronism the external impedance is somewhat less than the resistance of the inductive coil. The action is, therefore, in effect the same as though the external resistance had been decreased directly as the speed increased. It is claimed that the starting device occupies so small a space that it can be placed in the rotating armature, so that no collector rings are required.

A common defect in all methods of speed regulation thus far described is the low efficiency at speeds far below synchronism. Attention has been frequently directed to the fact that the efficiency is in any case less than the speed in per cent of synchronism. In order, therefore, to run at high efficiency at reduced speed, it is necessary to adopt some method of decreasing the synchronous speed.

The synchronous speed of a motor is equal to the alternations of the system divided by the number of poles of the motor. If, therefore, a motor is arranged for two different numbers of poles it will have two different synchronous speeds. While offering many advantages over other more complicated systems of speed control, and introducing no unsurmountable difficulties in practical application to existing types of motors, this method has as yet passed little beyond the stage of experimental investigation.

With mechanical connection between two motors, "concatenation" or "tandem" control also offers a means of reducing the synchronous speed. In practice, the secondary of one motor is connected to the primary of the other, the primary of the first being connected to the line. The frequency of the current in the secondary of any motor depends upon its slip, as noted above. At standstill, therefore, the frequency impressed upon the primary of the second motor will be that of the line. As the motor increases in speed the frequency of the secondary of the first motor decreases, and at half speed the frequency impressed upon the primary of the second motor will be equal to the speed of its secondary; that is, it will have reached its synchronous speed. If now, the primary of the second motor be connected to the supply circuit and the secondary of the first motor be connected to a resistance, the motors will tend to increase in speed up to the full synchronism of the supply.

By the use of suitably selected resistances for the secondary circuits of the two motors, this method gives the same results as the series-parallel control of direct-current series motors, with one important distinction, however. The series-wound motors tend to increase indefinitely in speed as the torque is diminished, while the induction motors tend to reach a certain definite speed, above which they act as generators. In this respect they resemble quite closely two shunt motors with constant field excitation, having armatures connected successively in series and in parallel, with and without resistance, and, like the shunt motors, when driven above the normal speed they feed energy back to the supply.

PISTON, CORLISS AND DOUBLE-BEAT VALVES.

In an able paper on valve gears delivered by M. Vanderstegen, managing director of the firm of Van den Kerchove, of Ghent, Belgium, to "La Société des Anciens Ingenieurs," Ghent, he gives reasons why the Corliss and double-beat valves have been abandoned (?) in favor of piston valves. This is very interesting, coming, as it does, from one of the most eminent makers of stationary engines in Europe. With few exceptions valve gears may be divided into two distinct classes; the one including all valve gears of the Corliss type, the other double-beat or Sulzer valves. The single piston valve, generally adopted for engines of high speed, is hardly applicable to large economical prime movers, since it entails so large a proportion of cooling surface and waste space; so that generally speaking for large stationary engines, the favors are divided between the Corliss and the Sulzer valve-gears, the United States, England and France adhering to the former, and Germany, Austria and Italy to the latter.

With entire impartiality it may be said of the Corliss valve, when properly constructed, that it fits well on its seat and assures a reliable and durable closing of the port, because the faces constantly grinding upon each other are kept in contact in spite of wear. The double-beat valve, on the contrary, often falls upon the seats, causing both a shock and a leakage, which increases daily until it is indicated by the large consumption of steam.

The chief merit of the Corliss valve is in the lap, which renders it superior to the Sulzer valve by giving perfect interception of the steam when closing, a quick opening and closing without shock, acceleration of speed before admission, and cushioning after cutting off the steam.

It has always been a delicate operation to regulate the air cushions of double-beat valves to suit a varying load, since the steam has to be quickly and completely intercepted without shock. This has been a weak point in double-beat valve-gears, and in central station work is very important. The Sulzer valve has, on the other hand, an advantage over the Corliss valve in that it is quite free from friction, which, especially at high pressures and temperatures, is very important, making the double-beat valve more reliable in this respect.

It also has another good quality; the valve, being almost in equilibrium and having but a short travel, requires but a very light gear to move it and the mechanism seems to work without effort; the more ponderous Corliss gear, with a more pronounced motion, has greater momentum and requires for the same speed more power to work it. The Van den Kerchove gear was designed to combine the good qualities of each of these gears, having a separate balanced and packed piston-valve for each port, working vertically in perforated bushings pressed into the admission exhaust passages at the cylinder ends and communicating with them by perforations around their entire circumference.

The valve gear resembles that of the Sulzer engines. The motion is taken from the crankshaft by a pair of miter wheels to a longitudinal secondary shaft provided with a separate eccentric opposite each end of the cylinder. As compared with the Corliss and Sulzer gears it is said to give complete interception of the steam when the valve is closed, due to the perfect roundness of the bushings and the arrangement of the piston valves and their packing rings, requiring but a slight permanent internal pressure upon their whole circumference to make them steam tight. The wear is reduced to a minimum, no hammering of the valves on their seats is present, as in the double-beat valve, nor can the bushing become oval as it might in time become with a rocking valve, the piston valves working vertically. Moreover, the valve being in perfect equilibrium, the initial pressure and consequently the number of expansions may be increased; but little power is required to open it; and it closes perfectly under all variations of load, a valuable quality for engines for traction work.

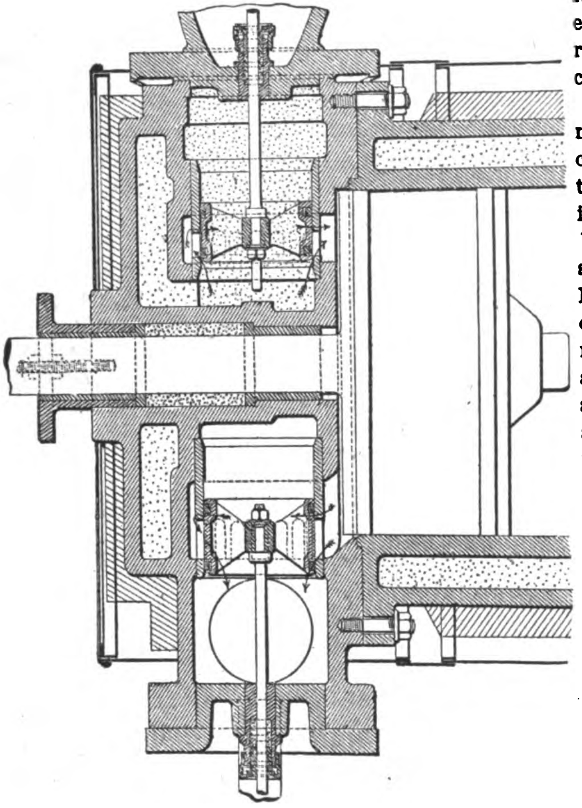

FIG. 1.—ADMISSION AND EXHAUST VALVES.

In the new Van den Kerchove engine the steam jacket is so arranged that it completely encloses the admission passages.

For those who may not be familiar with the Van den Kerchove gear it may be of interest to add that the valves are placed in the cylinder heads, as shown by Fig. 1, herewith, the admission being above the exhaust. Each valve operates by its lower edge only, and is kept tight by metal packing rings at the top and bottom edges. The valve has a free way through its center, and is thus balanced. As there is no seat for the valve to fall upon when released by the trip, the lower side of each dashpot piston is faced with leather, and this falls upon the bottom of the dashpot. The steam enters around the admission casing and under its lower edge, passing thence to the cylinder through slots in an inset cylindrical seat and through a ring channel surrounding this seat and opening on the inside surface of the cover.

It will be noticed that these piston valves differ from the usual American type of piston valve in that they close by a trip disengagement and under spring and dashpot control; and they each act at one edge or end only. The system thus embodies an effort to combine the advantages of ordinary slides, Corliss valves and gear and double-beat valves. A view of the trip gear is shown by Fig. 2.

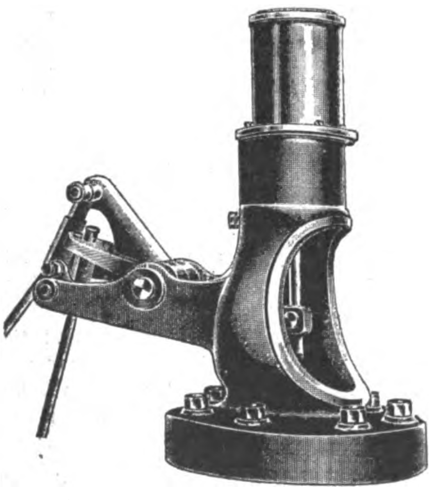

FIG. 2.—VAN DEN KERCHOVE TRIP GEAR.

THE SINCLAIR BOILER.

BY H. F. SCHMIDT.

In last month's issue of the American Electrician there appeared a description of a water tube boiler designed by Mr. George Sinclair, which was reprinted from London *Engineering*. Thinking that probably a discussion of the construction of the boiler might be of value to the readers, I present the following:

By examining the illustration of the boiler, it will be seen that the circulation of the water is forward through the lower bank of tubes, and that most of the water not evaporated in its passage through them, will, as is claimed, flow through the upper bank to the rear header. It is evident, however, that in its passage through the tubes it must necessarily be partly evaporated, the steam being disengaged in the rear header. In order that this may reach the steam drum it must pass through the nipples connecting the drum and the rear header, opposing in great measure the downward flow of the water to replace that which was evaporated in the tubes. It is evident that under these conditions circulation of the water cannot take place properly between the tubes and the drum; the water replacing that evaporated in the tubes can only reach the tubes by a spasmodic action which should never be relied upon to take the place of positive circulation.

It must be said, however, that as the volume of the steam bubbles is inversely proportional to the pressure, the evil effects produced by the upward flow of the steam disengaged in the rear header become less as the pressure is increased, but even at the highest pressures it would be an absolutely prohibitive objection.

There are two methods by which this difficulty might be obviated. The simplest way of overcoming it—though this is only a partial remedy—is to introduce the feed water into the front header; then the only water circulating through the steam drum would be that which was

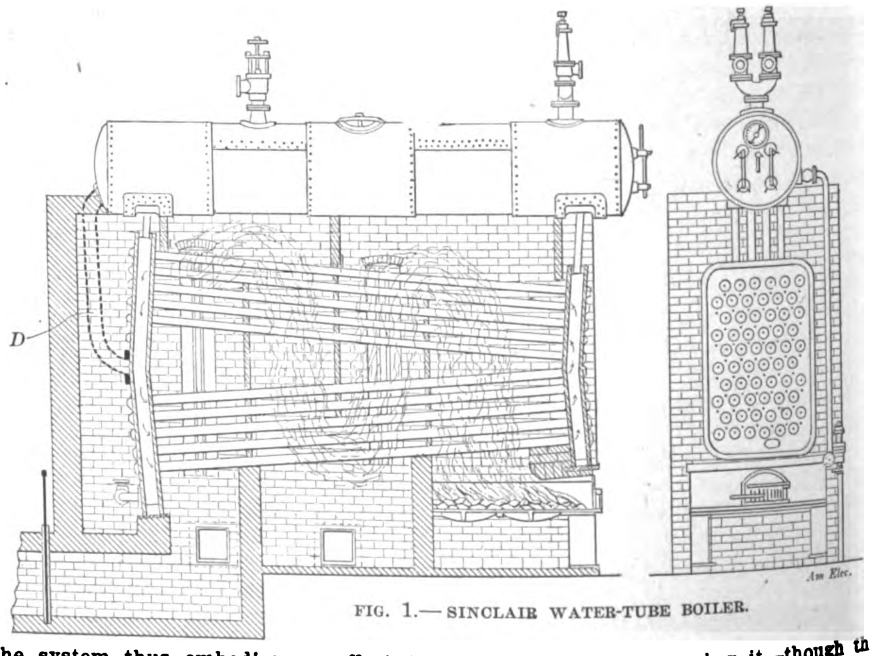

FIG. 1.—SINCLAIR WATER-TUBE BOILER.

carried up into it by the rush of steam through the nipples, but this arrangement does not permit the benefit to be gained that results from injecting the feed water into the steam drum. The second method, which would change the boiler into a highly efficient generator, consists in merely connecting the steam drum and the central space of the back header between the two banks of tubes by a couple of 6-in. downcasts, as indicated in the engraving by dotted lines at *D*. Even with this change, the circulation in the rear header would be far from perfect, though much improved.

It is worthy of note that the general principle on which the boiler is constructed is excellent; namely, that of using the upper half of the total number of tubes to return the water to the rear header. This reduces the length of the circulation to a minimum, whereas in all other boilers the water must either pass the length of the water drum or through special downcasts to reach the rear header. In both cases, it must pass through space where it is not exposed to the hot gases of combustion, and is therefore not necessary, and furthermore, in quite a number of cases the downcasts are placed outside the setting in order that the cooling action of the air may help to produce a proper circulation, which is certainly not economical and, to say the least, not scientific.

As to the space formed near the rear header between the two banks of tubes, it can only be said that it is useless, for when the products of combustion reach it their temperature must be so much reduced that the gases would not burn as claimed by the inventor.

In conclusion, it may be said that in a boiler constructed on Mr. Sinclair's principle, the rear header should be made of ample area, so that the ascending bubbles of steam disengaged within it may not interfere with the circulation; also, that the use of stayed surfaces is an objection, because scale which is formed on such surfaces is very difficult to remove. Moreover, unless very carefully made, they are an element of danger, and even if properly constructed they are comparatively expensive compared with the use of a separate header for each vertical row of tubes.

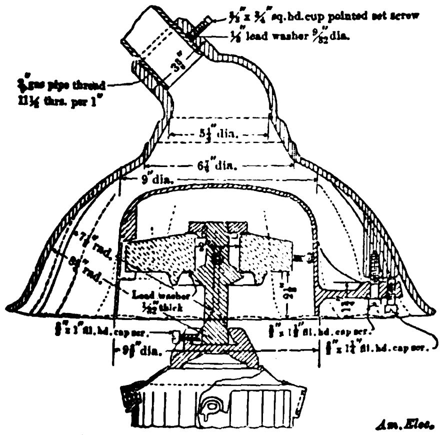

FIG. 2.—CROSS SECTION OF HOOD.

THE LIGHTING OF DIVERSEY BOULEVARD, CHICAGO.

BY J. B. CRAVATH.

The electric lighting of Diversey Boulevard in Chicago affords one of the best recent examples of boulevard lighting in the United States. The boulevard is the last completed link in the chain of boulevards which connects the six great outlying parts of Chicago, and now has the distinction of being the best lighted boulevard in the city.

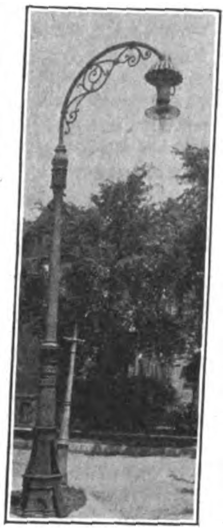

FIG. 1.—LAMP POST.

The lamps are series direct-current enclosed arcs, taking 6.2 amperes at 72 volts. They are placed every 150 feet diagonally along the boulevard, one post being placed every 300 feet on each side of the street. There are 98 of these lamps in all. They are of Western Electric Company make, with opal inner globes and clear outer globes, surmounted by a 26-in. steel shade. Fig. 1 shows a post and lamp complete. The bottom of the globe is 17 ft. above the street surface and the highest part of the post is 22 ft. from the street surface. These posts, from the base to the curved portion, were taken from the posts used on the grounds of the World's Columbian Exposition in 1893, and the curved top was added. The lower portion of the pole, which is 7 ft. high, weighs from 850 to 900 lbs.; the middle section weighs 250 lbs., and the bent piping, with its casting, weighs 154 lbs. The hood over the lamps weighs 59 lbs., and the scroll 39 lbs. In the base one of the panels was cut out for a door. This was done by chipping around the edges with a cold chisel and breaking out the panel.

The arrangement for hanging the lamp and insulating it from the pole is of interest, because of the excellent provision made to withstand the high pressure of about 8500 volts, which is used on the circuit. Fig. 2 is a cross-section within the hood, showing the method of suspending the lamp. The top of the lamp, part of which is shown in the lower portion of this figure, is fastened rigidly to a shank which passes up through the large porcelain insulator and is held by a nut at the top of the shank. This porcelain insulator, as will be seen, is very large, being 7½ ins. in diameter over all, and 3⅛ ins. from the hole in the center to the periphery. On the lower side of this insulator is a petticoat for increasing the leakage distance between the middle and outside and to afford a convenient drip for any moisture. Any leakage over the top of this insulator must take place over a still greater surface than over the bottom, because a small space is left around the periphery, as shown in the drawing. The insulator is supported by a cap or hood, the function of which is that of protecting the insulator from any scale that might rattle down out of the bend in the lamp post from above. Lead-covered cables, from the underground system, come up through the lamp post and pass down outside of this hood, entering the lamp directly through the bushings indicated in the drawing.

As the lamp is fastened rigidly without any opportunity to swing it was, of course, necessary to provide means for adjusting it in plumb, as it would be unreasonable to expect the pole tops to be absolutely true. To this end, the three arms which support the insulator-protecting hood are held in the canopy by cap screws which can be adjusted to bring the hood level and the lamp vertical, as shown in the drawing. A set screw at the side of each supporting screw holds the hood rigid after adjustment is made. All the cable used, both in the poles and in the underground ducts, is lead-covered, equivalent in cross section to No: 6 B. & S. gauge, and was made by the Simplex Electrical Company. In the posts a stranded conductor is used, but in the street the conductors are solid. The insulation is rubber, tape and braid. The rubber composition is guaranteed to stand a break-down test of 5000 volts for each thirty-second of an inch of thickness. As the insulating walls are 7/32 in. thick in these cables the break-down

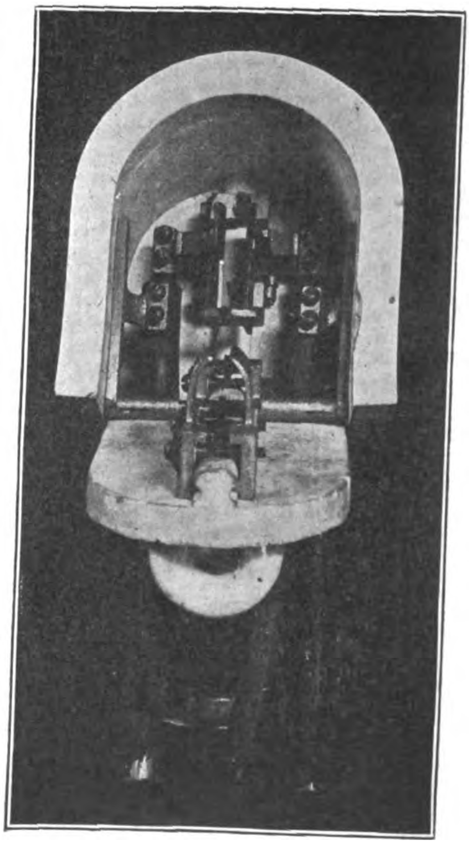

FIG. 3.—DOG-HOUSE TYPE, ARC LAMP CUT-OUT.

test guaranteed is 35,000 volts. Outside of the rubber are two tapings, wound spirally in opposite directions, and two coats of braid.

Tests were first made on samples of this cable after immersion in water for sixty hours. Pressure from a 5-kw. transformer was first put on at 5000 volts and raised gradually to the specified voltage of 35,000. After the cable was pulled in and all connections were made, the whole system was tested. As it was found that the 5-kw. transformer which was available for testing would not supply the charging current required by the condenser capacity of the lines and hold up its normal voltage, it was only possible to get the voltage up to 25,000, by testing one side of the street or half the lamps at a time. Short sections, however, were tested at 35,000 volts. It might be well to mention here that each side of the street is on a circuit of its own and that after midnight the lamps on one side of the street only are run. The lamps that run on one side of the street after midnight on one night are put out after midnight the following night, so as to alternate the service and give an equal consumption of the carbons on both sides of the street, in order to avoid waste in trimming.

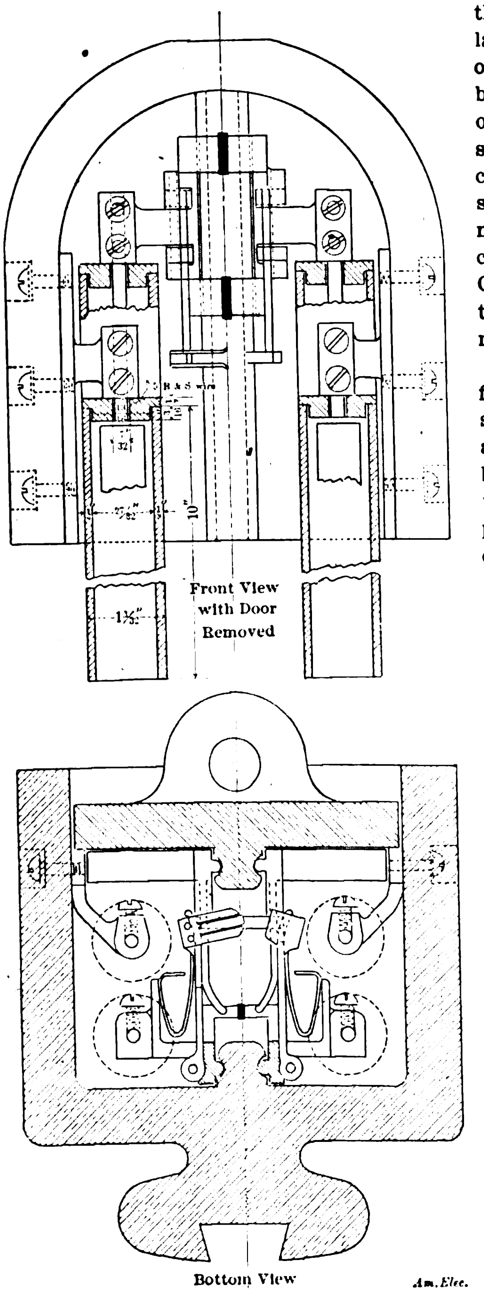

FIG. 4.—DETAIL VIEWS OF CUT-OUT.

A new high-voltage cut-out switch was designed for this work by the Western Electric Company. This is located in the base of the pole. A photograph of this cut-out is reproduced in Fig. 3, and detailed drawings are shown in Fig. 4. The whole switch is enclosed in porcelain. When the door is open, as shown in the engraving, the lamp at the top of the pole is entirely cut off and insulated from the balance of the circuit. The breaking distance of the contact switch, with the door fully open, is 6 ins., which is sufficient to open the lamp circuit, even if there is a heavy ground on the lamp. The lamp terminals are led to the switch jaws on the door. The line contacts are in the back of the box, and the withdrawal of the line contacts allows the knife switch, shown in Fig. 4, to close the main circuit. The cables leading into this switch have the lead covering removed for a distance of 12 ins. and are covered by hard rubber tubes filled with Chatterton compound. Over the top of these tubes is placed a hard rubber cap, making a very thorough job.

The post foundations are of concrete, 3 ft. square at the bottom and about 30 ins. square at the top, with a sub-base hexagonal in outline to conform to the pole base. Three ¾-in. x 36-in. anchor bolts were set in the foundation to hold the pole. The concrete mixture was six parts crushed limestone, three parts sharp sand and one part Portland cement. West of Clark Street, which is the greater part of the distance, the cables were run in 3-in. tile socket pipe placed from 24 to 36 ins. below the surface under the parkway. Brick manholes 24 ins. in diameter by 36 ins. deep with 4-in. wall, were placed opposite each lamp post. East of Clark Street it was not practicable to lay the ducts in the parkway, because of large trees which had been growing for fifteen years, and which would have been injured by digging a ditch for the conduit. McRoy 3-in. duct conduit was, therefore, placed in the street 4 ft. from the south curb and a lateral run across to each pole from the manholes, which are 4 ft. x 4 ft. x 6 ft. deep. The conduit was laid 36 ins. below the street surface. The manholes have cement floors, with a 6-in. drain tile and trap in the bottom. Iron covers 26 x 32 ins., and weighing 850 lbs., are supported by angle irons on top of the brickwork. A plan of one of these manholes is shown in Fig. 5.

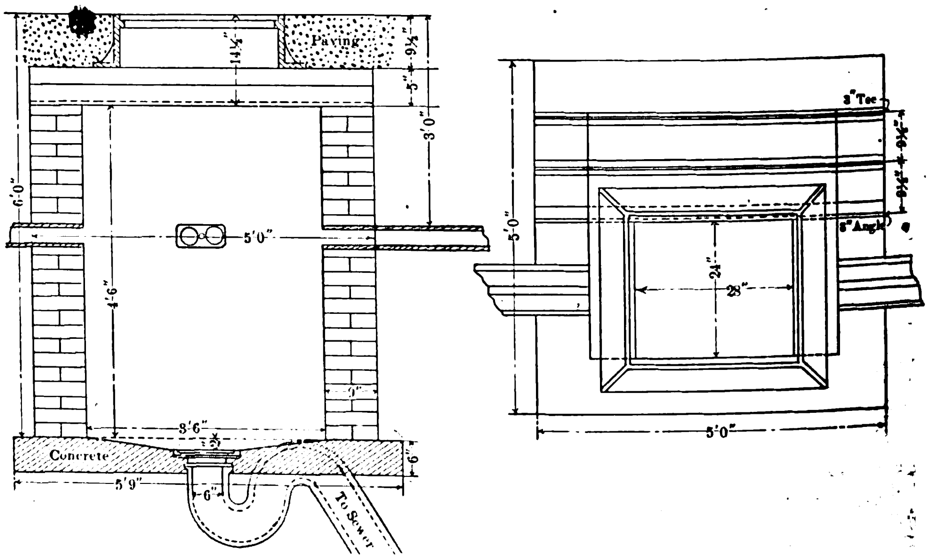

FIG. 5.—DETAIL AND PLAN VIEWS OF MANHOLE.

This excellent piece of construction was done by the Lincoln Park Board of Chicago, under the supervision of its electrical engineer, Mr. Harold Almert.

TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

TRUNK LINES.

Although the number of trunk lines in any exchange is small in comparison to the number of subscribers' lines, their presence will, to some extent, affect the location of the offices. If it is required to make a correction in the location of the offices for trunk lines, the number of trunk lines must be determined first. A method of determining this was given in the preceding article, but as the value of the formulas was completely nullified by printers' errors, this method will be repeated here.

As stated in an early article of this series, there are two classes of trunk lines, "outgoing" and "incoming," and each "outgoing" trunk line from a given office is an "incoming" trunk line at the office to which it extends. In order to determine the number of outgoing trunk lines required for any one office, it is necessary to estimate the number of trunk-line calls that will be made per day. Experience has shown that a trunk line can accommodate an average of 110 trunk calls a day, so that if the number of probable outgoing trunk calls is known, the number of outgoing trunk lines is ascertainable by dividing the probable number of calls by 110.

The percentage of subscribers' calls that necessitate trunking is found by means of the formula:

$$0.75 \frac{C - c}{C} \quad \dots\dots\dots\dots (1)$$

in which *C* is the average number of calls made on the entire exchange per day, and *c* is the average number of calls per day for the one office under consideration. The result of this formula gives the proportion of the total number of daily calls, *c*, that will require trunking. Consequently, the probable actual number of outgoing trunk calls from the one office whose daily calls are represented by *c* may be ascertained by means of the formula:

$$0.75 \frac{C c - c^2}{C} = Tc$$

which may also be written:

$$0.7 \left(c - \frac{c^2}{C} \right) = Tc \quad \dots\dots (2)$$

As stated above, each trunk line can carry 110 calls per day, so that the theoretical number of trunk lines required for the office having the daily number of calls represented by *c* would be obtained by dividing the result of the above formula by 110. It is advisable, however, to add a few trunk lines as a factor of safety, and it has become customary to add 0.8 trunk line for each office. Thus, if an exchange contains *n* offices, 0.8 (n—1) trunk lines should be added. This gives as the final expression for the number of outgoing trunk lines required for each office the following:

$$Tl = \frac{0.75 \left(c - \frac{c^2}{C} \right)}{110} + 0.8 \; (n - 1)$$

This formula may be made a little more convenient of application by writing it as follows:

$$\frac{0.75 \left(c - \frac{c^2}{C} \right) + 88 \; (n - 1)}{110} = Tl .. (3)$$

Tl being the required number of outgoing trunk lines for an office having *c* daily calls in an exchange having a total of *C* daily calls.

For example, suppose an exchange has two offices, one of which has 1200 daily calls and the other 800 daily calls. The total daily calls for the exchange would, therefore, be 2000. In such a case the value of *c* for the larger office would be 1200; the value of *C* would be 2000; the value of *n* would be 2; and substituting these values in formula (3) would give:

$$\frac{0.75 \times \left(1200 - \frac{1{,}440{,}000}{2000}\right) + 88 \; (2 - 1)}{110} =$$

4.07. As it is manifestly impossible to have a fractional number of lines, 4 would be the number of outgoing trunk lines for the larger office. The value of *c* for the smaller office being 800, substitution in the formula would result as follows:

$$\frac{0.75 \times \left(800 - \frac{1{,}440{,}000}{2000}\right) + 88 \; (2 - 1)}{110}$$

= 1.34 outgoing trunk lines for the smaller office. In this case two lines would be installed.

In all modern exchanges having more than one office, the orders for trunking are transmitted between the offices over separate "order-wires" which connect the operator's telephone sets at one office with the operator's sets at the other offices. Experience has shown that one order-wire circuit is required for every 20 outgoing trunks; in the case of the small exchange just assumed, only one order-wire circuit would, therefore, be necessary each way between the two offices.

Assuming for the present two offices only, and that the number of trunk lines between the two offices has been found as above described, then it becomes necessary to find the length of all subscribers' lines and to locate the offices temporarily, without regard to the trunk lines, by the method described in a previous article. Then, if the trunk lines be represented by *Tl*, the length of the trunk lines would be *Tl* × the distance between the two offices. Representing this distance in miles by *m*, the total length of trunk lines would be, obviously, *Tl* × *m*.

A certain percentage of this trunk line mileage would be alloted to each office, according to the distance from the office to the dividing line between the two office districts, but if the location of the dividing line is determined as described in a previous article, it will be halfway between the two offices, so that each office district will contain $\frac{Tl \times m}{2}$ miles of trunk line.

Now, if the aggregate of the lengths of all subscribers' lines for one office be represented by *a*, and the corresponding aggregate for the other office by *b*, then the offices must be shifted toward the dividing line until the sum of *Tl* + *a* + *b* is a minimum. That is to say, the preliminary locations of the two offices must be moved toward each other until the sum of the lengths of all subscribers' lines in both offices added to the sum of the lengths of all trunk lines is the smallest possible figure. This will be the case when the increase in the aggregate lengths of subscribers' lines due to shifting the location of an office is equal to the decrease in trunk line length due to the same shifting.

For example, if one office be located temporarily on the map two miles north of the dividing line between the two office districts, and the distribution of subscribers in that district is such that there are 20 subscribers north of the street on which the office is located and 30 offices south of that street, then moving the office toward the dividing line will lengthen the lines of 20 subscribers, transfer some subscribers from the south to the north of the office, and shorten the lines of the subscribers still remaining south of the office, by the extent to which it is moved. Thus, suppose the aggregate lengths of the subscribers' lines extending north of the office to be 5000 ft., and the aggregate lengths of those extending to the south of the office to be the same number of feet, and that shifting the office 100 feet southward (toward the dividing line between the two office districts) would transfer ten subscribers from the south to the north of the office. The lines of the 20 subscribers originally north of the office will be lengthened by 20 × 100 = 2000 ft.; the lines of 20 subscribers originally to the south of the office will be shortened by 20 × 100 = 2000 ft. Now, suppose the lines of the ten subscribers, who by this shifting have been transferred from the south to the north of the office, to have been lengthened a total of 500 ft.; then the net result in the grand total of subscribers' line lengths will be an increase of 500 ft.

The prospective trunk lines will have been shortened 100 ft. each, and if there were to have been five of these, the required balance would have been obtained. As a matter of fact, however, it is highly improbable, in a case such as that assumed, that five trunk lines would be necessary, so that it would not be necessary to shift the office as much as 100 ft. southward in order to obtain a balance between the lengthening of subscribers' lines and the shortening of the trunk lines.

If there are many offices in the exchange, the effect of the trunk lines will not be very considerable upon the offices located near the general center of the entire exchange district, on account of the compensating lengthening of trunk lines on one side of such an office when it is moved to shorten trunk lines on the other side of it. It is only the location of the offices situated near the outskirts of an exchange that need be considered in connection with the number of trunk lines. If, however, there are only a few offices, the necessary shifting of these offices on the preliminary diagram may be considerable, so that it may be advisable to calculate in great detail the effect of shifting them, as indicated broadly above.

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Manufacture of Turf-Charcoal by Electricity.—A factory has been erected at Strangfjorden, Norway, for the electrical treatment of turf. This is first dried and formed into blocks by pressure and then enclosed in retorts and heated by internally placed resistance coils to the requisite temperature. A gas useful for illuminating and heating purposes is obtained, while a tarry liquid distills over which can be worked up for paraffine, ammonium sulphate, and methyl alcohol. The turf-charcoal remaining in the retorts is a useful substitute for either wood-charcoal or gas-coke.

An Independent Central Energy Exchange and Toll Line Office

THE EXCHANGE AT ALTON, ILL.

Considerable success has attended the efforts of the independent telephone companies to establish toll-line facilities in the middle western states, one company, with headquarters at St. Louis, Mo., devoting its entire energies to this class of work.

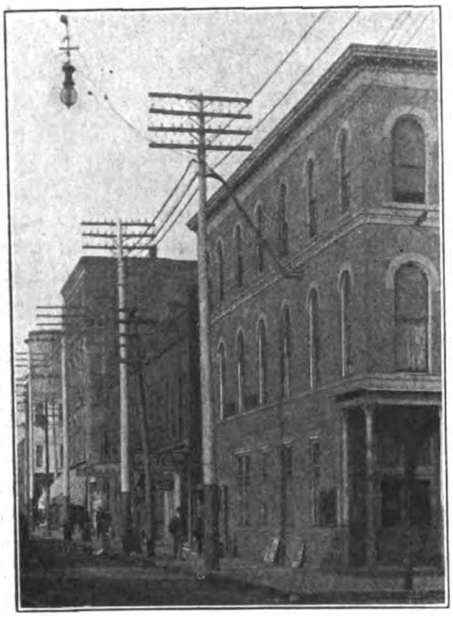

FIG. 1.—SHOWING ENTRANCE OF CABLES.

The object of this company (The Kinloch Long Distance Telephone Company of Missouri) is to provide long-distance connections between cities in the state of Missouri, and as the city of St. Louis is located so near the border of the state of Illinois, the company's operations have extended into the southern part of the latter state. One of the largest exchanges thus far established as a part of the long-distance scheme is the one at Alton, Ill. The switchboard of this exchange has a capacity of 3000 lines; as the exchange was built chiefly as a link in the long-distance system, interest in the switchboard is not incited so much by its size as by its equipment.

The system used is the common-battery relay system, in which a single battery is located at the central office and supplies current for talking as well as for signaling. The telephone equipment supplied to subscribers does not include any battery or generator. As in all of the modern central-energy systems, the subscriber calls up the exchange by simply taking the receiver off the hook, this action causing a small incandescent lamp on the exchange switchboard to light in the manner described in one or two articles by other writers which have been published previously in the AMERICAN ELECTRICIAN. Fig. 1 shows the method of bringing the cables into the building, and Fig. 2 shows the main switchboard and chief operator's desk.

Each operator has all subscribers represented by multiple jacks in front of her, so as to enable her to reach any subscriber in the exchange. It has been found that this is the best method of operating quickly. With each pair of plugs there are associated two small lamps which enable one to supervise the connections. As soon as the operator has inserted the second plug into the multiple jack of the called-for subscriber, the supervisory lamp associated with the calling plug will light, indicating to the operator that the called-for subscriber has his telephone still upon the hook. At the time of inserting the calling plug, the operator rings the called-for subscriber by means of a ringing key, and as long as the lamp associated with the calling plug remains lighted, she knows that the called-for subscriber has not responded. As soon as he responds, this lamp is extinguished.

The supervisory lamp associated with the answering, *i. e.*, the plug the operator inserts into the jack of the calling subscriber, does not light at present, and this is unnecessary, because the operator knows that the calling subscriber is ready for conversation and waiting at his telephone. Whenever the calling subscriber hangs up his telephone, however, the supervisory lamp associated with plug that is inserted in his jack is lighted. When both of the supervisory lamps glow, therefore, the operator knows that both subscribers have finished conversation, and she can restore the plugs to their normal condition. In Fig. 2 it will be noticed that on the first "position" neither lamps nor multiple jacks appear; instead, there are drops with jacks below. This position is used for toll and long distance connections. Arrangements are made so that any toll line or long distance line may be connected to any common-battery local line or *vice versa;* also that any toll and long distance line may be connected to any other toll and long distance line, of course. Drops are used on these lines because the toll and long distance stations are, as a rule, so small that it would not pay to put in a common battery equipment; with such an equipment a storage battery and charging machines have to be installed.

To the right in Fig. 2 a chief operator's desk is shown. This desk is provided with connections to the local board so that the chief operator is able to converse with any subscriber in the exchange, and can "listen in" on any conversation, if necessary.

Fig. 3 represents the rear of the switchboard. In the lower part the relays are shown, and above the relays the cables terminating at the jacks and lamps. In the upper part of the switchboard a bank of condensers is shown, these condensers being used in the operators' cord circuit to transmit from one part of the circuit into the other without direct metallic connection. Above the condensers are such coils as are required for the operator's outfit to enable her to talk to the subscribers as well as to test whether the line of the called for subscriber is free. Each operator is provided with two pilot lamps, one of which is lighted every time the line lamp of a calling subscriber lights, and the other one is lighted every time one of the supervisory lamps lights. At night the usual night bell is inserted in the pilot circuit.

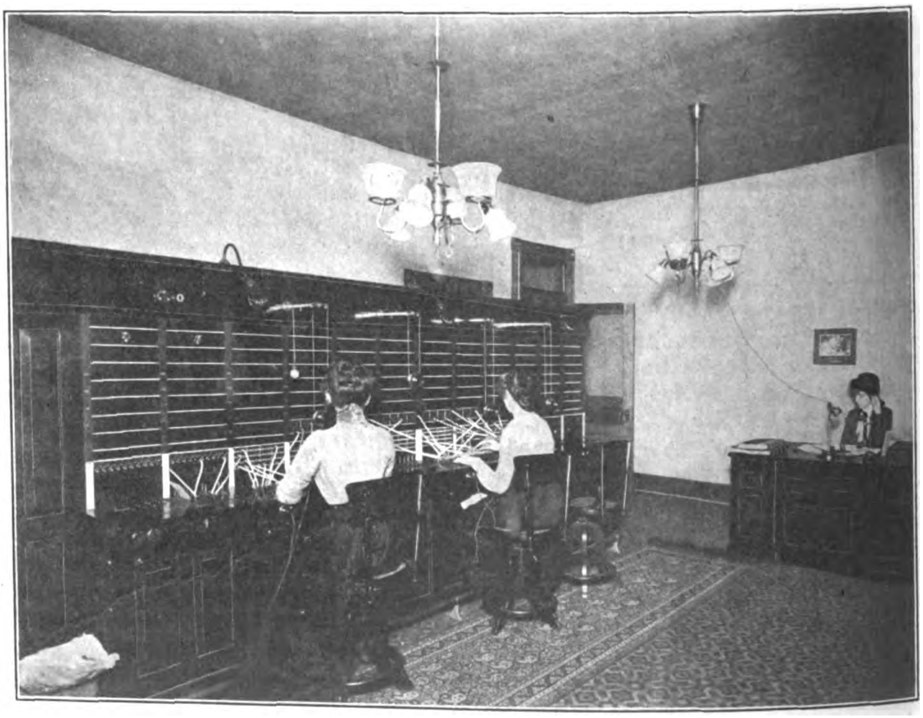

FIG. 2.—VIEW IN SWITCHBOARD ROOM OF ALTON TELEPHONE EXCHANGE.

Fig. 4 shows the cable terminal heads at which the outside lines terminate. Lightning arresters and sneak current protectors are provided upon these terminal heads. From the terminal heads the lines are continued into the so-called distributing board and terminate there at the connectors to which they are soldered.

Fig. 5 shows the front of the distributing board upon which the lines terminate. There is an open gap in the line, as the terminals of the lines going to the switchboard are soldered to connectors upon an adjacent strip. This gap is left to enable any line on the outside to be connected to any line in the switchboard by a so-called jumper wire.

It often happens that subscribers move and do not like to change their telephone number, and in order to change the switchboard jacks, lamps, etc., from one line to another without interfering with the service, this gap in the distributing board is left; any two terminals upon the upright strip upon which the lines from the outside terminate, can be connected to any two terminals on the upright strip, by simply connecting a pair of wires between these connectors. In order to keep these wires in systematic shape, rings are provided through which the jumper wires are drawn. Fig. 4 shows the rear of the distributing board, partly equipped with the jumper wires drawn through rings.

The distributing board shown in Figs. 4 and 5 is made in halves, one-half being devoted to cross-connecting the lines that come in from the outside to the lines on the switchboard. This board is usually called the main distributing board. The other half of the distributing board (which was not equipped when these three views were taken) may be entirely separate from the main distributing board; it serves to distribute the "load" among the operators. As it is not known at the beginning of operations which subscribers will call often and which will not, and as one operator may happen to be burdened with a number of subscribers who call only a few times a day, it is made possible by the use of this distributing board to change over subscribers from one operator to the other, and thereby distribute the load upon the operators evenly. The principle of distribution of these lines on the intermediate distributing board is the same as upon the main distributing board.

Fig. 6 illustrates the power machines and the power board. The power machines consist of charging generators in duplicate. These charging generators are

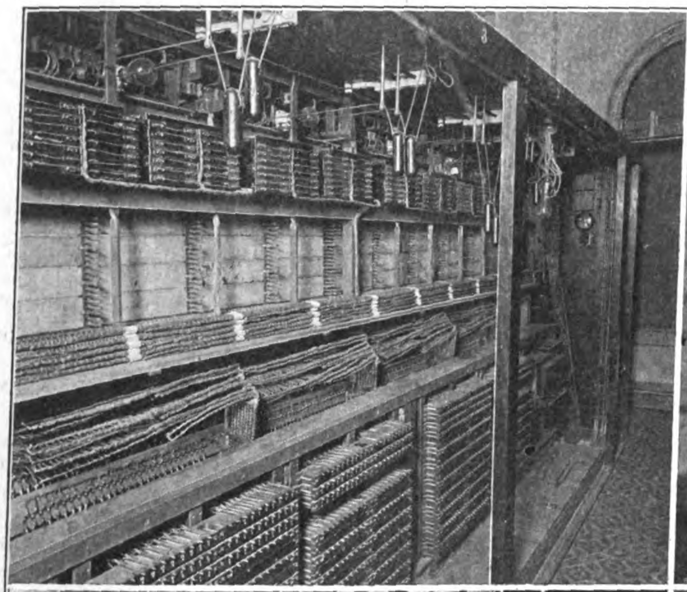

FIG. 3.—REAR VIEW OF SWITCHBOARD.

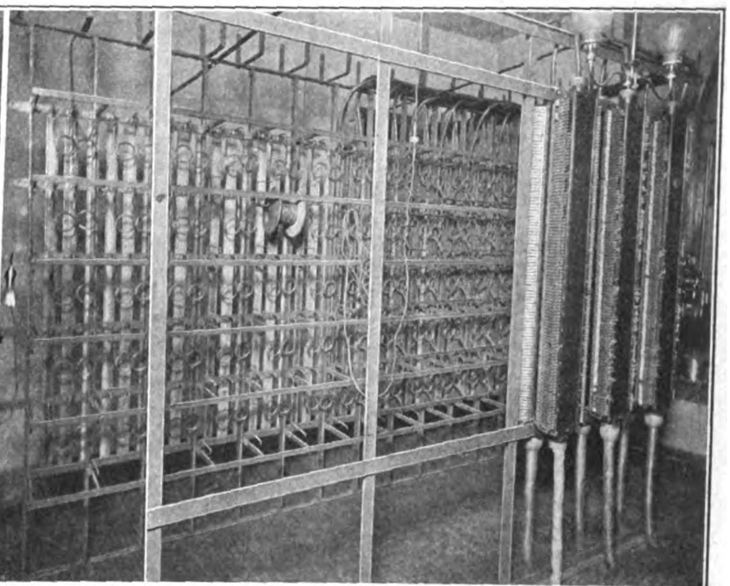

FIG. 4.—CABLE TERMINAL HEADS AND DISTRIBUTING BOARD.

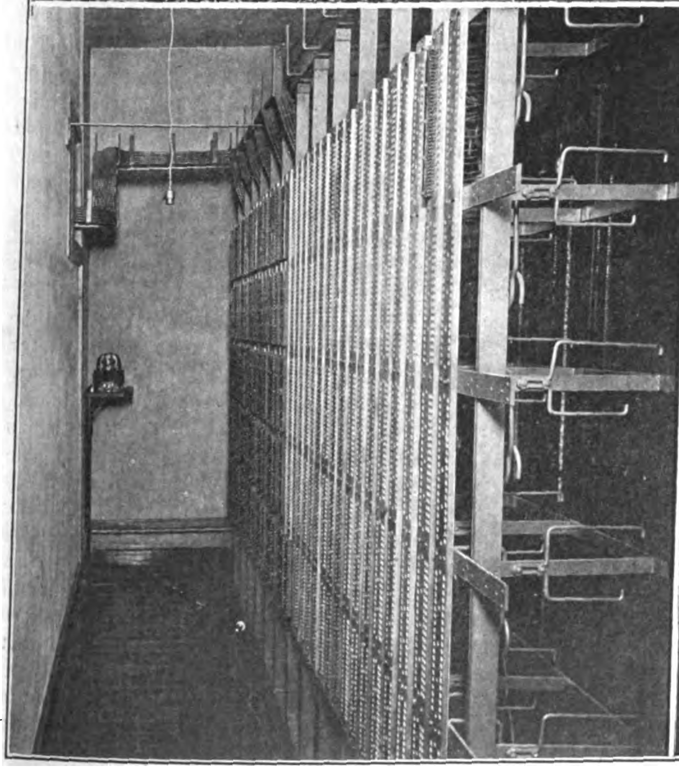

FIG. 5.—FRONT VIEW OF DISTRIBUTING BOARD.

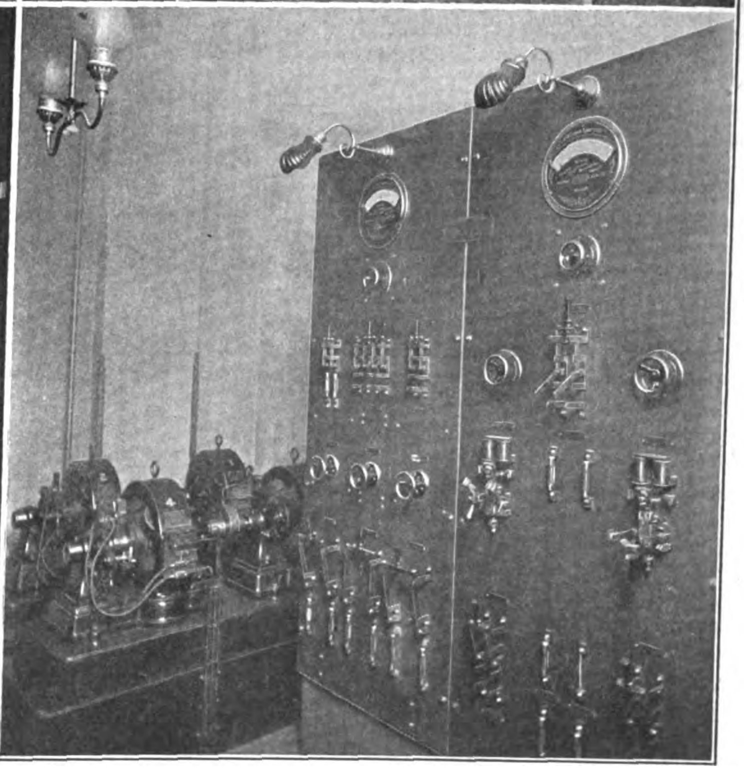

FIG. 6.—MOTOR-GENERATORS AND POWER SWITCHBOARD.

driven from the city electric light mains and are merely motor-generators, the motor side being built for the voltage of the city mains and the generator side being able to deliver current at 30 volts. Two storage batteries are provided, of 11 cells each. Each battery is charged by one of the motor-generator sets. The switches on the power board are arranged, of course, so that either of the motor-generators can be used to charge either of the storage batteries. The usual starting and regulating devices are provided, together with a voltmeter and an ammeter, and suitable connecting switches, so that the pressure and current in any lead may be measured. Motor-generators are also used for ringing purposes, the motor winding taking current from the city mains and the secondary side given a 110-volt alternating current.

The central exchange was completely installed by the Kellogg Switchboard & Supply Company, of Chicago. Mr. Chas. H. Ledlie, chief engineer of the Kinloch Long Distance Telephone Company, should be awarded great credit for having provided the city of Alton with a good telephone service at moderate rates.

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BOILER TESTING.

BY CHAS. L. HUBBARD.

When a long and accurate test of a boiler plant is to be made, an experienced engineer should always be employed to take charge of the work, and for such this article contains nothing new or of special interest. It does happen, however, that the operating engineer is often called upon to assist the consulting engineer in his work, or else wishes to make a simple test of his plant himself, in order to compare various grades of coal or different methods of firing, and to this class a brief description of how to carry on a test and make the necessary computations may be of interest.

In general, the object of a boiler trial is to determine the quantity and quality of steam the boiler will supply under given conditions; the horse-power of the boiler and its efficiency, and the amount of fuel it takes to make the required steam. The quantity of steam is taken as the amount of water evaporated; the quality is determined by one of the forms of calorimeter already described in previous articles; the efficiency is the ratio of the heat units utilized in evaporating the water to the total heat supplied to the boiler. The heat utilized in evaporation is calculated by multiplying the number of pounds of feed-water by the number of heat units required to change water at the temperature of the feed-water into steam at gauge pressure. The heat units supplied are determined by weighing the fuel used during the test and after deducting the amount of ash multiplying the result by the total heat of combustion of the fuel.

The heat of combustion is obtained either by calculation or by means of a fuel calorimeter. These determinations must necessarily be made by a person familiar with this kind of work, and are beyond the scope of this article. However, in making comparisons it is not necessary to know the heat value of the different kinds of coal. For approximating the efficiency of the boiler, one may assume a pound of the best Pennsylvania anthracite coal to contain 14,000 heat units and a pound of average Cumberland coal from 12,000 to 13,000 heat units. Other grades range from 9500 to 14,500 heat units per pound.

Before starting on a test one should have the specific object of the trial in view, and each step should be carefully arranged beforehand with reference to it. The following rules covering the preliminaries of a test will be found useful for reference, and will assist the engineer in preparing for any special investigations:

1. Measure and record the dimensions and position of the grate and heating surfaces, flues and chimneys, proportion of air space in the grates, kind of draft, etc.

2. Put the boiler in good condition by having all heating surfaces clean, with grates and furnace walls free from clinkers. See that all smoke passages are free from obstruction, and that all leaks in the masonry are closed.

3. The coal should be dry, or if wet a sample must be carefully dried and a determination of the amount of moisture made, so that the final results can be properly corrected. If the test is for establishing the efficiency of the boiler, it should be made, if possible, with some standard coal of known quality, and in all important tests a sample of the coal should be selected for analysis.

4. All apparatus, such as scales, tanks or measures, water meters, thermometers, gauges, etc., should be checked and compared with standards, if possible.

5. Before beginning a test, the boiler and chimney should be heated to their usual working temperature. If the setting is new, the boiler should be in continuous use for at least a week before testing.

6. See that the boiler and all connections are free from leaks. All water connections, including the blow-off and extra feed pipes, should be disconnected or stopped with blank flanges, except the pipe through which the boiler is to be fed during the trial.

If an injector is used, it must receive steam directly from the boiler being tested, and not from the steam pipe of any other boiler. The steam pipe should be arranged so that the condensation cannot run back into the boiler. If the connections are such that this will naturally happen, drip connections should be made and the water trapped and weighed. A test to be of value should last at least ten hours, and twenty-four is much better for important work. The conditions of the boiler and furnace in all respects should be as nearly as possible the same at the beginning and end of the test; the steam pressure and water level should be the same, and the fire upon the grates should be the same in quantity and condition.

There are two common methods of starting and stopping a test, known as the "standard" and "alternate" methods. In the first method steam is raised to the working pressure, and the fires are quickly drawn, the damper closed and all refuse removed from the ash-pit. A new fire is started at once with a known weight of wood and coal. At the end of the test the fires are again drawn and the ash-pit cleaned. The water level should be as nearly as possible the same at the end of the test as at the beginning. It will usually be necessary to regulate the flow of steam from the boiler by means of the stop valve for a time, while the fires are being drawn at the beginning and end of the test, in order to keep the steam pressure in the boiler up to the average during the test.

The alternate method is as follows: At the regular time for cleaning the fires have them burned rather low, then thoroughly clean and note the amount of coal left on the grate as closely as possible; then take the steam pressure and the height of water in the gauge glass, and the time of starting the test. Fresh coal, which has been weighed, should then be fired and the ash-pit thoroughly cleaned. Before the end of the test the fires should be burned low, just as before the start, and cleaned in such a manner as to leave the same amount of fire and in the same condition as at the start. The water level and steam pressure should be brought to the same point as at the beginning, and the time of ending the test should be noted just before fresh coal is fired.

During the test the boiler should be run continuously without stopping for meal-times or for rise or fall of pressure due to the change in demand for steam. The draft should be adjusted as nearly as possible to give the desired rate of combustion, and should be kept practically constant during the test by means of the damper. If the boiler is not connected to the same main with other boilers, an extra steam outlet with a valve should be provided, so that the pressure may be reduced if it runs too high, without checking the fires.

If the boiler is one of a battery and is connected to a common main, the safety valve on the boiler being tested should be set a few pounds higher than those on the other boilers, so that in case of a rise in pressure the other boilers may blow off and the pressure be reduced by closing their dampers, allowing the damper of the boiler being tested to remain open, while the firing is carried on without change. All the conditions should be kept as nearly uniform as possible, such as force of draft, steam pressure and height of water level. The time of cleaning the fires will depend upon the character of the fuel, the rate of combustion and the type of grate used. When a good quality of coal is used and the combustion is not too rapid, a ten-hour test may be made without cleaning, except at the beginning and end of the test. If the quality of coal is such that cleaning becomes necessary, it should be done at regular intervals.

The coal should be weighed and delivered to the fireman in equal portions, each sufficient for about an hour's run, and a fresh portion should not be delivered until the previous one has been used. The time required for burning each portion should be recorded by noting the time of the first firing of each new portion. At the same time the amount of water fed into the boiler should be carefully recorded, also the height of the water line and the steam pressure, and the temperature of the feed. By keeping the records in this way the test may be divided into sections if desired. For ordinary tests, such as the engineer of a plant would be apt to carry on this is not necessary, as the totals for the entire run will be sufficient.

In order to make the necessary computations relating to a test, the following must be known: First, the weight of coal burned and amount of ashes left; second, the weight of water fed into the boiler; third, the steam pressure carried; fourth, the temperature of the feed-water as it enters the boiler; fifth, the quality of the steam discharge from the boiler.

There are various ways of determining the amount of feed-water used. The best method is to weigh it in barrels upon accurate scales. Two or more barrels should be used, and of such size that the filling and weighing need not be hurried. They should be placed high enough to discharge into the tank or barrel from which the boiler is fed. The barrels should be numbered and the weight of each when empty should be recorded and deducted from the weight when full. When the water level in the feed tank has fallen so that it will hold another barrel of water, one of the barrels which has been filled and weighed should be emptied into it while another is being filled. At the beginning of the test the water level in the feed tank should be marked, and at the end should be brought to the same level. The level in the gauge glass of the boiler should be noted in the same manner. The temperature of the feed-water should be taken at regular intervals, so that an average may be taken at the end of the test.

The coal should be weighed in barrows or barrels, and fired directly from the barrows or barrels, or it may be dumped upon the floor before firing. The barrows should be weighed and their weight subtracted each time. Any unburned coal at the end of the test must be weighed and the amount subtracted from the total. The condition of the fire should be the same at the beginning and end of the test. For a long test of twenty-four hours or more it may be estimated by the eye; if the test is short, the standard method may be used if it is desired to be more accurate. If this method is employed, the fire should be allowed to burn low and the pressure be kept up by reducing the amount of steam taken from the boiler. About half an hour before beginning the test the fire is drawn and a new one started with wood. When coal is first thrown on, the test is started. Toward the end the fire is again burned low and at the end is drawn out and quenched with as little water as possible. The unburned coal is picked out and its weight subtracted from the coal fed into the furnace. The clinkers and ashes are separated and weighed with the clinkers and ashes formed during the test. The wood used is weighed and considered as equal to 0.4 the same weight of coal.

The temperature of the feed-water is best taken by means of a thermometer in a cup filled with oil and screwed into the feed pipe near the check valve. If the temperature is nearly constant, readings may be taken once in fifteen minutes; if it varies much, the readings should be taken oftener. The steam pressure should be kept as nearly constant as possible, and should be practically the same at the beginning and end of the test. Readings should be taken in the same manner as above described for the temperature of the feed-water. The quality of the steam may be obtained by means of a throttling separator or barrel calorimeter, the first two being preferable on the score of accuracy.

In making complete tests, samples of flue gas are taken from the chimney uptake and back of the bridge wall. The object of this is to determine whether the proper amount of air is admitted to secure complete combustion. The chimney draft is usually obtained by means of a U tube partially filled with water. A rubber tube is attached to one leg of the tube and is inserted into the chimney through a small hole drilled for this purpose. A difference of ¼ in. in the water level in the two legs indicates a moderate draft; ⅜ to ½ in., a moderately strong draft, and ¾ to 1 in., very strong. As the chances of error in making a boiler test are so great, care and accuracy must be used throughout, both during the test and in working up the data.

In order to make comparisons of the efficiencies of boilers working under different conditions of steam pressure and temperature of feed-water, it becomes necessary to reduce the working conditions to a common standard. The standard adopted is called "equivalent evaporation from and at 212 degrees," which means in any given case that the heat required to change a certain quantity of feed-water at a given temperature into steam at boiler pressure, would evaporate a different and definite quantity of water from a temperature of 212 degrees into steam at atmospheric pressure. For example, a boiler carrying a pressure of 90 pounds gauge, and supplied with feed-water at a temperature of 60 degrees evaporates 3000 pounds of water into steam per hour. What is its equivalent evaporation from and at 212 degrees?

From a steam table we find that the temperature of steam at 90 pounds pressure is 331 degrees, and the "heat of vaporization" is 880 thermal units; then for one pound of water the "heat in liquid" above the temperature of the feed-water is 331 — 60 = 271 thermal units, and the "total heat" is 271 + 880 = 1151 thermal units; therefore, the heat required to raise the temperature of 3000 pounds of water from 60 degrees and evaporate it into steam at 90 pounds pressure is 1151 × 3000 = 3,453,000 thermal units. Looking in the table again we find the "heat of vaporization" for steam at atmospheric pressure to be 966; therefore, 3,453,000 ÷ 966 = 3574 pounds, the equivalent evaporation from and at 212 degrees. The ratio, 3574 ÷ 3000 = 1.19 is called the "factor of evaporation" for the conditions given in the problem. Engineers' handbooks and many boiler catalogues contain tables giving the factors of evaporation for varying combinations of feed-water temperature and steam pressure.

The method of recording the results of a test and making the necessary computations may be shown by the results of an actual test upon a 250-h.p. water-tube boiler.

Data.

Heating surface—2552 sq. ft.
Grate surface—57 sq. ft.
Ratio of grate to heating surface—1 to 44.7.
Kind of fuel—Cumberland.
Rated horse-power—250.

From Observation.

Steam pressure (average)—125 lbs. (gauge).
Chimney draft—.11 in. of water.
Temperature of feed-water—210 degrees.
Pounds of coal burned—5713.
Pounds of refuse—490.
Pounds of water fed to boiler—60,217.
Quality of steam from calorimeter—99.94 per cent.

Computed.

Pounds of combustible—5713 — 490 = 5223.
Proportion of refuse—490 ÷ 5713 = .86, or 8.6 per cent.
Coal burned per hour—5223 ÷ 8½ = 672 lbs.
Coal burned per square foot of grate per hour—672 ÷ 57 = 11.78 lbs.
Total water evaporated—60,217 × 99.94 = 60,181 lbs.
Water actually evaporated per pound of coal—60,181 ÷ 5713 = 10.54 lbs.
Water actually evaporated per pound of combustible—60,181 ÷ 5223 = 11.5 lbs.
Water actually evaporated per pound of coal from and at 212 degrees—$\frac{60{,}181 \times 1046}{5731} =$ 11.01 lbs.
Water actually evaporated per pound of combustible from and at 212 degrees—

$$\frac{60{,}181 \times 1046}{5223} = 12.05 \text{ lbs.}$$

Horse-power developed during test—

$$\frac{60{,}181}{8.5 \times 34.5} = 205.$$

Efficiency of boiler—Assuming each pound of coal of this grade to contain 13,000 thermal units, the total heat given up by the coal is 5713 × 13,000 = 74,269,000 thermal units. The total heat utilized by the boiler is 60,181 × 966 = 58,134,846 thermal units. Therefore, the efficiency is—

$$\frac{58{,}134{,}846}{74{,}269{,}000} = .78, \text{ or 78 per cent.}$$

Abstracts from Foreign Contemporaries

The Leitner Accumulator.—A recent issue of the London *Electrical Times* contains a description of the Leitner accumulators for automobiles and for traction work. Fig. 1 shows the automobile cell. The positive plate is of the Planté type, coated with crystalline peroxide formed from porous lead. The negative elements are of electrolytic porous lead, which has a different structure from and a higher density than, the usual spongy lead formed by the reduction of the paste of lead oxide and acid commonly employed.

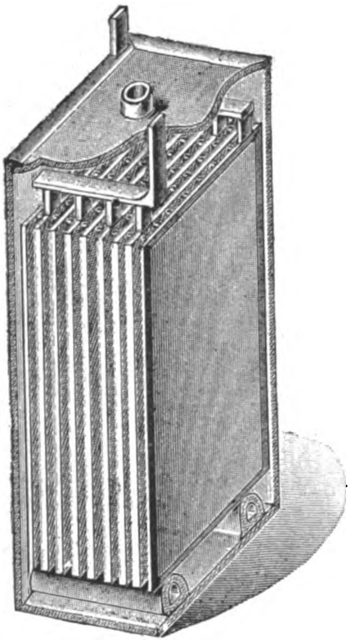

FIG. 1.—AUTOMOBILE CELL.

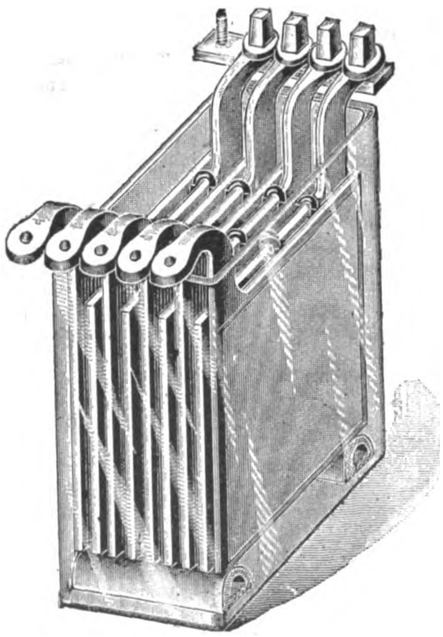

FIG. 2.—LIGHTING AND POWER CELL.

The compound on the Leitner negative plate is quite hard and can scarcely be marked by the finger nail. No grid is employed, metallic lead being used of only sufficient thickness to carry off the current. The cell shown has eight plates, which are contained in an ebonite case. In the heavy traction type of cell the positive plates are of Planté formation, having a network of lead laminations with internal pockets so as to allow of the internal passage of the acid. The negative elements are similar to those employed in the automobile cell, but are stronger. In the cell intended for lighting and power purposes the positive element consists of an interwoven network of lead laminations very similar to those employed for heavy automobile work, but very much stronger. Grid negatives are used, porous lead being pressed into the spaces in the plate. The whole grid is cast in an undercut manner so that no active material can fall out. No pellets of the active material are really formed, for the whole of the porous lead is practically connected together, diagonal central lead conductors being provided to conduct the current. This type of cell is shown in Fig. 2. It will be noticed that each element is connected separately to its neighbor by means of a nut and bolt and lead washer, so that in case one case should lose its capacity or break down in any way, it can be replaced without interfering with any other. The plates are shown resting on hollow ebonite bridges, but it is usual to suspend them from the sides of the cell, leaving a clear space between the edges of the plate and the bottom of the cell, so as to avoid liability to short circuiting by any deposit in the bottom. In both the light and heavy traction cells, however, hollow ebonite bridges are used. In a test made on a battery listed at 200 ampere-hours at a ten-hour discharge rate the curves showed that at the normal rate of discharge the battery gave 220 ampere-hours, at 25 amperes it gave 212 ampere-hours, at 30 amperes 202, and at 35 amperes 201 ampere-hours. The same battery was tested for higher rates of discharge with satisfactory results.

New Coherer.— According to *Le Figaro* Edouard Branly has carried out under the auspices and with the assistance of the Société Francaise des Télégraphes Sans Fil, an improvement on the coherer. Under the present system the coherer consists of a glass or ivory tube half filled with nickel and silver filings, and inserted in the electric circuit. It appears that in order to receive and transform the Hertzian waves under most favorable conditions Mr. Branly has found it is sufficient to place in contact any two metallic pieces, provided that one of these be polished and the other oxidized. In other words, he has discovered that a contact between an oxidized piece of metal and a polished piece possesses the property, like the tube of filings, of not letting any current pass unless an electric spark occurs within a certain radius. This new radio-conductor, it is claimed, is very sensitive and simple in construction.

High-Tension Distribution Boards.—The Ashton high-tension distribution board recently described in the London *Electrical Review* is shown by Fig. 3, herewith. The ends of the fuse block cases are of cast iron, while the sides and lids are of sheet steel covered with vitreous enamel. When fixed on a flat wall a sheet of asbestos, or of iron, placed on the wall before affixing the case, forms the back. Each of the porcelain fuse slabs is provided with ½-in. holes passing laterally through it, and two ¼-in. iron rods, *C* C^1, threaded their whole length and covered with sleeves of rubber tube, *B* B^1, pass through these holes. The slabs are thus strung upon the rubber-covered rods and are clamped tight by nuts outside the two ends. Rubber washers, *A* A^1, are inserted on the rods between each pair of slabs, so that the slabs are well insulated. In securing the slabs into their own case they are first clamped together as desired, forming one rigid structure. The two ends, *F* F^1, of the rods, which are turned down conical, are inserted in two ⅛-in. holes drilled in one side of the case, and the double-shouldered nuts, *D* D^1, are then screwed outward until their smaller shoulders enter the holes, *E* E^1, in the other side of the case. In the engraving, the nut, D^1, is shown screwed up tight in the case, and *D* is shown in the free position. By tightening these nuts against the case, the two rods and consequently the fuse slabs carried by them, are held firmly and securely.

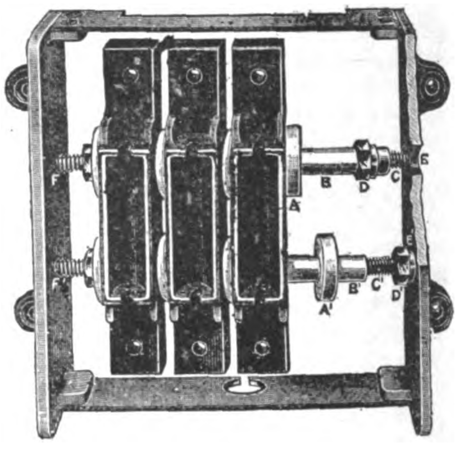

FIG. 3.—HIGH TENSION DISTRIBUTING BOARD.

The Peard Fuse.—On the switchboard of the new direct-current station of the City of London Electric Lighting Company, recently described by English contemporaries, patent fuses are mounted and connected to each pole of the circuit. The fuse is the invention of O. L. Peard, and is illustrated by Fig. 4, herewith. It is of novel and simple construction, the object being to reduce to a minimum the duration of the arc, by mechanical means, and to screen the connecting terminals from the metallic vapors formed. The device consists of a bridge or central block, *A*, of non-conducting material, interposed between the terminals to which the fuse is fastened. This central bridge contains a slidable screen, *B*, which is pressed continuously outwards against the fuse at its weakest point by a spring, *S*. The connecting terminals are protected from metallic vapor formed by the volatilization of the fuse by means of an outer cover, *C*, which is fitted round the central block, the fusible connection being exposed only at the point where it passes over the sliding screen. When the fuse blows the screen is instantly interposed between the two parts of the fuse at the moment of fusing. The rapidity with which the screen works and the very small quantity of metal actually fused is said to effectually prevent the formation of a destructive arc, and the arc formed at the moment of breaking the circuit is entirely confined to the replaceable fuse at its point of severance.

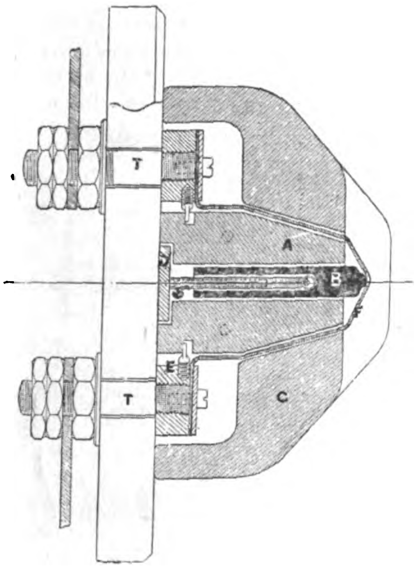

FIG. 4.—PEARD FUSE.

German Nernst Lamps.—The London *Electrician* describes in a recent issue the 1902 Nernst lamp as made by the Allgemeine Elektricitäts Gesellschaft, of Germany. The lamp is of the self-lighting type, with a heating coil which is automatically disconnected from the circuit, in the now familiar manner, as soon as the filament is sufficiently hot. A diagram of the connections is shown by Fig. 5. The heating coil, *B*, surrounds the glower, *C*, and is connected to the mains through the contact of a relay armature. The relay magnet in series with the glower cuts out the heater as soon as current begins to pass through the glower, precisely as in the American Nernst lamp mechanism. The "ballast" or steadying resistance necessary to compensate the negative temperature coefficient of the glower is made in the form shown by Fig. 8, resembling a miniature incandescent lamp. This is held in a small bayonet socket, and is contained within the hood *H*, as shown by the dotted lines in Fig. 8. Brass springs, *S S*, within the hood, protect this resistance from jarring, this being advisable, because the device, enclosed as it is in thin glass, is rather delicate. The springs also serve to assist in the dissipation of the heat evolved, for which purpose the corrugated strips, *G G*, are also provided. Three contacts, *J K L*, project below the lamp to connect with the glower and heater. The flat piece of metal, *K*, slides against the central contact of the "burner," and is fastened to it by means of a screw. The split rods, *J* and *L*, are of different sizes, so that it is impossible to connect the "burner" wrongly. The hood rests on and fits into the ring *M* (Fig. 9), which also holds the globe, and contact is made to what may be termed the cut-out plate by the plugs *P P*, which are of vulcanized fiber fitted with brass bushings that pass over the split terminal pins, *O O*. For connecting up the lamp, it is only necessary to remove the top cap, *Q*, shown in Fig. 9, when the terminal plate, *T*, becomes accessible. Fig. 10 shows the general arrangement of the lamp. All of the exposed parts are of lacquered brass, and the bases of the glower or "burner" plate, cut-out plate and terminal plate are of unglazed porcelain. In wiring direct-current lamps, directions are given as to the polarity. It is imperative to connect the positive and negative wires to their proper terminals, otherwise, it is said, the glower will be quickly destroyed. The lamps are made in three sizes: One-half ampere and 1 ampere at from 196 to 250 volts, and 1 ampere at from 96 to 150 volts.

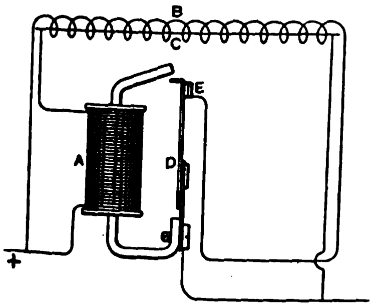

FIG. 5.—DIAGRAM OF HEATER CONNECTIONS.

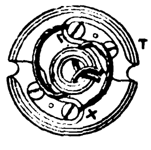

FIG. 6.

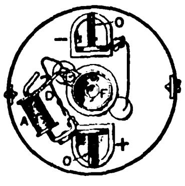

FIG. 7.

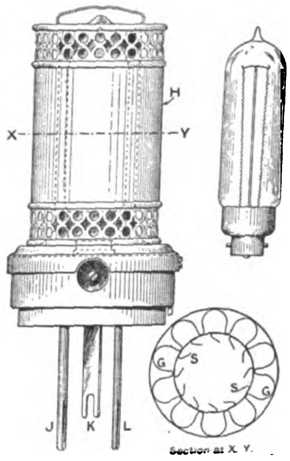

FIG. 8.—NERNST LAMP HOOD.

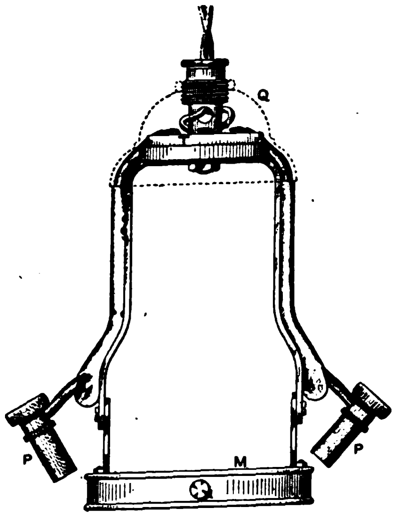

FIG. 9.—SECTION OF OUTER COVER.

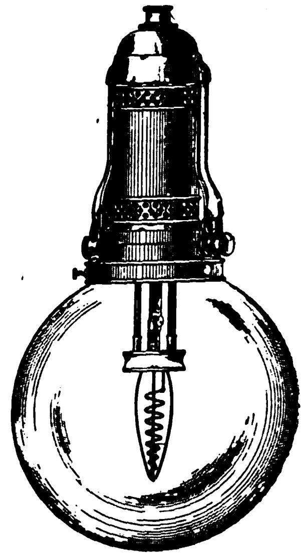

FIG. 10.—NERNST LAMP.

Electrolytic Chlorates and Hypochlorites.—The *Zeitschrift fuer Elektrochemie* contains the results of a research by Foerster and Müller bearing on the efficiencies of the electrolytic processes for the manufacture of chlorates and hypochlorites. The latter in previous investigations of the chemistry of these processes had proved that the addition of chromates in small amounts to the electrolyte has a most marked influence in checking the reduction losses at the cathode. In later experiments, the results of which have just been published, the two investigators find that the most favorable conditions for the production of hypochlorite are obtained when the neutral salt solution containing potassium chromate is electrolyzed with a "platinum black" electrode, the temperature being kept low during the electrolysis. Under these conditions a current efficiency of 96 per cent can be attained with an e.m.f. of only 2.4 volts, and solutions containing up to 38.5 grammes of active chlorine per liter can be obtained. The use of platinum black electrodes in place of electrodes of ordinary platinum foil increases both the current and energy efficiency of the cell process in a remarkable manner. The only difficulty in the application of such electrodes to technical work is that the platinum sponge is somewhat troublesome to prepare, and that it exhibits a tendency to separate from the supporting platinum when used as anodes under a high current density. The authors hope, however, to overcome this difficulty shortly. Regarding the formation of chlorate in the electrolytic cell the authors found that the use of a platinum black anode with an electrolyte containing potassium chromate and free hydrochloric acid enabled them to obtain a yield of chlorate approaching theoretical figures. Two-thirds of the chloride present could be converted into chlorate with a current efficiency averaging over 94 per cent.

Lightning Arresters.—The *Electrotechnische Zeitschrift* contains in a recent issue an interesting article on "horn" lightning arresters, by Eugen Klein. As is doubtless well known, lightning safety devices for electrical apparatus usually consist of a spark-gap connected between earth and the apparatus to be protected, as shown in Fig. 11, and a few turns of wire placed in the connection to the apparatus itself. The atmospheric discharge, which is generally of an oscillatory character, is "choked" out of the path containing the inductive resistance and passes to earth by means of the spark-gap. If a dynamo is to be protected against atmospheric discharges, it is further necessary to provide for the prompt breaking of the connection to earth formed by the spark-gap. Of the numerous instruments proposed for this purpose, those constructed without moving parts deserve the preference. A special class of the latter consists of those known as the "horn" lightning arresters from their distinctive shape. These were first introduced by Professor Elihu Thomson, who employed an electromagnetic blow-out to get rid of the short-circuited arc; the latter was driven upwards along the horns, becoming longer and longer through the increasing distance between the plates and finally broke up. A simplification of the Thomson device made by Siemens & Halske eliminates the electromagnetic blow-out entirely. The discharge plates are narrow, and are so shaped that the spark-gap lies above the wires connecting the horns to the circuit. The electrodynamic action of the current in the horns on the arc then drives the latter upwards. The author found that even with the unsatisfactory form of horn shown by Fig. 14 a very energetic expulsion of the arc could be insured by casing the horns with iron, and thus producing an unsymmetrical distribution of the field surrounding the arc. The action of such a lightning arrester may be explained as follows: The field produced in the air by a wire carrying a current is concentric to the wire, as is well known. If, now, a piece of iron be brought in the neighborhood of the wire, the field becomes distorted somewhat, as shown in Fig. 12, and the number of lines becomes increased. They lie partly in the iron, and in attempting to shorten their path still more they exert a pull on the latter. This effect is made use of here. The magnetic attraction between the iron and the wire causes the latter to tend to approach the iron. If now the part *a b*, of the wire consists of an arc, this will, in consequence of its small mass, experience a powerful attraction towards the iron. Nothing will be altered if the iron be cut and opened out, and the ends of the wire *a* and *b* be provided with horn-like extensions, as shown in Fig. 13. When employing horns of the Thomson type, the effectiveness of the iron plates can be improved by means of added shoes, as shown in Fig. 14. By the addition of such shoes the shape of the horns can be altered at will. On this account the preference has been given to those forms employing large masses of metal, as these are more capable of dissipating the heat set up by the short-circuit, and are not so likely to be bent out of shape as the thin wire horns. The original Thomson form has been, therefore, retained, but with the addition of iron sheaths. Fig. 15 shows one of the forms now made.

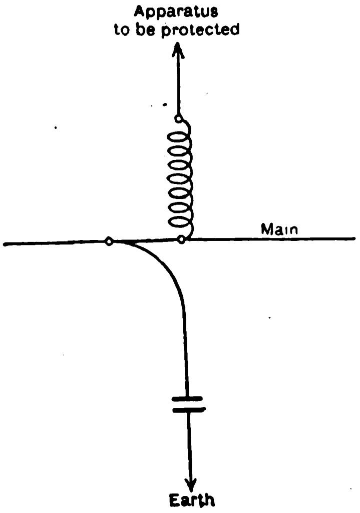

FIG. 11.—DIAGRAM OF CONNECTIONS.

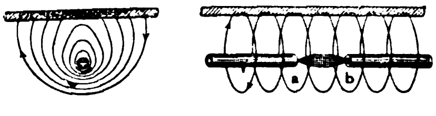

FIG. 12.—DISTORTED FIELD.

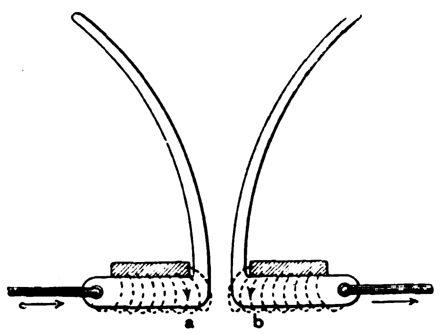

FIG. 13.—THIN HORNED LIGHTNING ARRESTER.

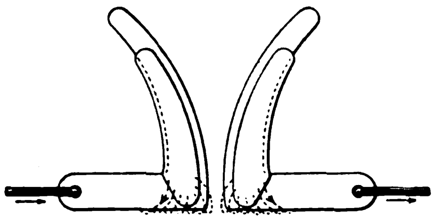

FIG. 14.—MODIFIED THOMSON LIGHTNING ARRESTER.

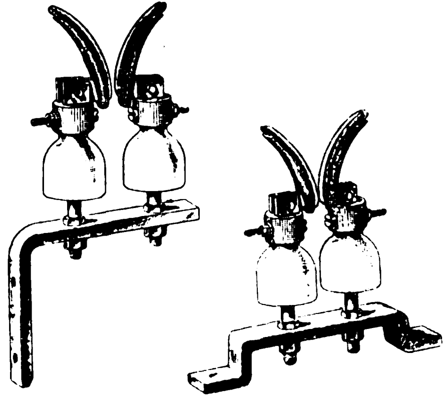

FIG. 15.—COMMERCIAL FORMS OF LIGHTNING ARRESTERS.

Lamp Tester.—Fig. 16 shows a lamp tester for readily determining the efficiency of incandescent lamps, which was described in a recent issue of the London *Electrical Times*. All that it is necessary to do is to put the lamp in the socket fixed to the instrument, as shown, and insert the plug attached to the flexible cord in a socket on a live circuit of proper voltage. The pointer will then indicate the exact current taken by the lamp at the supply voltage on which it is being lighted. A table is provided with the instrument, from which the efficiency of any lamp in watts per nominal candle-power can be found from a knowledge of the voltage and a reading taken on the lamp tester. The instrument is portable and spring controlled, and is adaptable for either direct or alternating current. The utility of the instrument might be augmented considerably if means were provided for ascertaining the voltage other than so unreliable a method as assuming it to be normal.

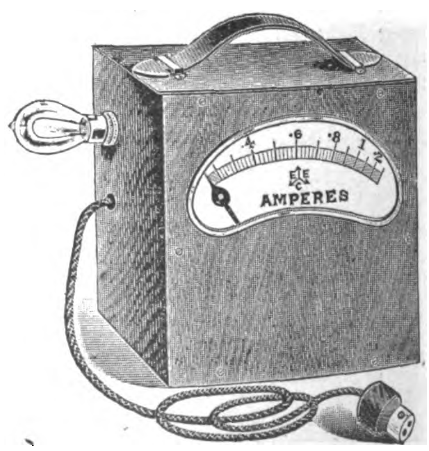

FIG. 16.—LAMP TESTER.

Some Recent Electrical Patents

Telephone Receiver Support.—Fig. 1, herewith, illustrates one of the latest methods of providing for freeing both hands of a telephone user while at the instrument. This device, which has been patented by George M. Beerbower, consists of a pivoted arm, *10*, somewhat similar to a transmitter arm, but provided with a telescoping extension, *14*, carrying a spring clamp, *18*, adapted to take the barrel of the receiver. The pivot of the arm is of somewhat unusual construction, being in effect a universal joint. The large end of the arm is made with a chamber or recess containing a spiral spring, which gives a yielding pressure sufficient to maintain the arm in any position to which it may be adjusted. There is a second pivot, *3*, at right angles to the pivot through the end of the arm, by means of which the receiver may swing toward or away from the ear. This pivot is also surrounded by a spiral spring, *6*, which tends to press the receiver against the ear of the user. The receiver hook is operated by the pressure of the head against the receiver; this action swings the receiver around on the pivot, *3*, slacking the helical spring, *21*, and allowing the receiver hook, *23*, to rise. When the pressure of the ear against the receiver is relaxed the spring throws it back to the normal position and pulls the hook switch down. Patent No. 695,268.

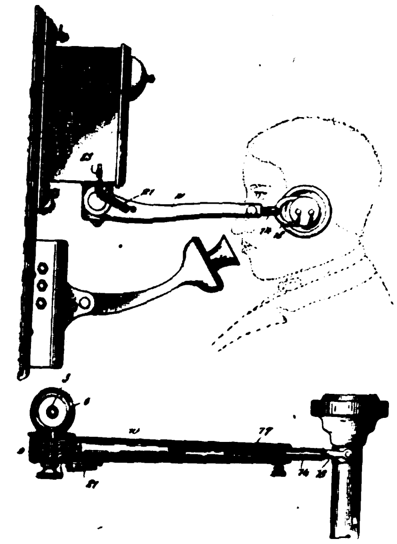
FIG. 1.—TELEPHONE RECEIVER SUPPORT.

Stored Signal System for Telephone Exchanges.—With a view to obviating the inconvenience and uncertainty attendant upon attempts to call up a subscriber to a telephone exchange when that subscriber's wire is busy, Newman H. Holland has devised the signaling systhem illustrated in Figs. 2 and 3, herewith. By means of this system the operator is notified by a special signal lamp when the desired line is idle, so that it is not necessary for her to listen in on the busy line nor to remember the number of the waiting subscriber who wishes connection with that line. Fig. 2 shows the arrangement applied to a local battery system, and Fig. 3 shows it as applied to a common battery system. Referring to Fig. 2 three stations are illustrated diagrammatically, it being assumed that Station 411 has asked for connection with Station 241, and that the latter station is already in connection with Station 1409. Under these conditions the central exchange operator will have notified Station 411 that Station 241 is busy, and will then place the plug *a* in an answering jack of Station No. 411, and insert the corresponding plug, *a2*, of that cord circuit in the calling jack of Station 241, as shown in the diagram, at the same time depressing the table key, *c*, which is a part of the special signaling system, and is not the usual listening-in and ringing key. With this key depressed, it is obvious that the sleeve strands of the two plugs are connected to one terminal of a special relay magnet, *p*, the other terminal of which is grounded. This, of course, grounds the jack thimbles of the busy line, No. 241, and the waiting line, No. 411. At the same time the jack thimbles of lines Nos. 241 and 1409, which are connected with each other, are connected by the signaling circuits on the left of the diagram to the positive terminal of the battery, *D*, of that cord circuit. This obviously gives a closed circuit for the left-hand battery, *D*, through the right-hand relay, *p*, which attracts its armature, as shown, allowing a drop to fall to a contact connected to the positive terminal of the local battery, *21*. Although the diagram does not show it, the armature and the small drop of the magnet, *p*, are connected together electrically by being pivoted to the same framework. The operation just described does not, of course, interfere with the conversation between Stations 241 and 1409, but when that conversation is finished, and the plugs, *a* and *a2*, of the cord circuit connecting those stations are withdrawn, the circuit of the left-hand battery, *D*, is opened, and the armature drop of the right-hand magnet, *p*, falls, closing the local circuit of the signal lamp, *23*, and notifying the operator that connection between lines 411 and 241 may be made. This connection is then effected by merely throwing the cam, *c*, which connects the tip strands of the two plugs, the sleeve strands being permanently connected. At the same time the operator restores the small drop of the magnet, *p*, and presses the ringing key of the cord circuit connecting lines 411 and 241, notifying the subscribers at both stations. In Fig. 3, illustrating the application to a common battery system, the principle of the arrangement is the same, but the cord circuit of the special signaling system is a single-strand circuit and special plugs, *e e*, are used, which make connection only with the thimbles of the jacks. The result is the same. So long as the plugs of a regular cord circuit are in the jacks, the lamp, *23*, of the special signaling system will

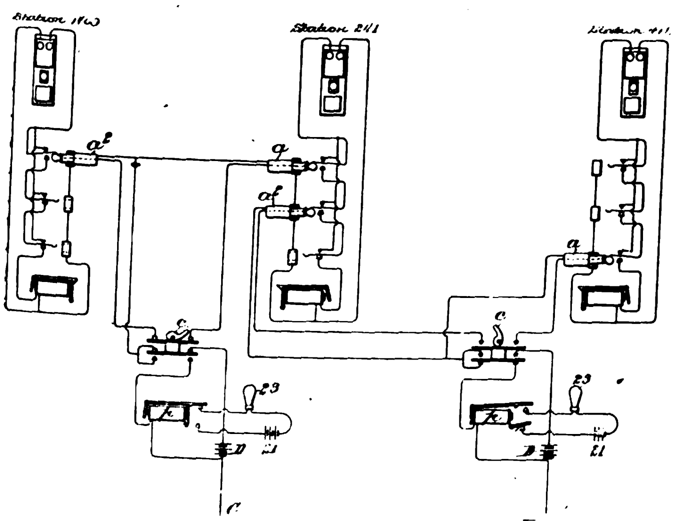

FIG. 2.—APPLICATION TO LOCAL BATTERY SYSTEM.

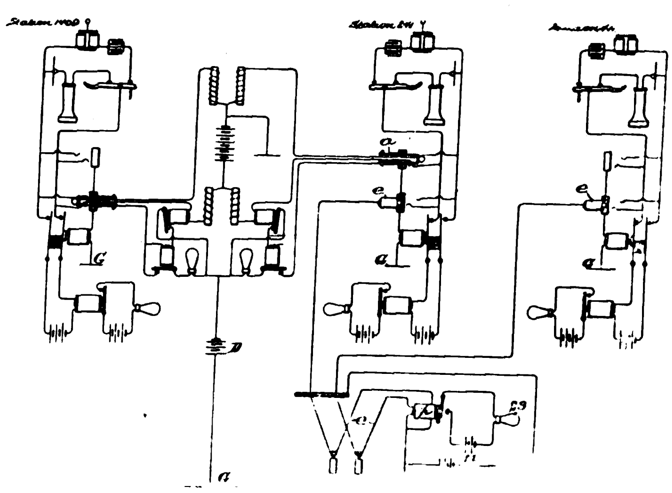

FIG. 3.—APPLICATION TO COMMON BATTERY SYSTEM.

remain unlighted, the circuit of the battery, *D*, being closed, as easily traced in the diagram, through the magnet, *p*, of the special relay. When the plug, *a*, is withdrawn from the jack of line No. 241, clearing that line, the signal lamp, *23*, lights up, notifying the operator that the waiting call may be made, and the special plugs, *e*, indicate which lines are to be connected together. These plugs are then withdrawn, and the regular cord-circuit plugs substituted. Patent No. 694,918.

The Hurricane Fan Motor Design

To the Editor, American Electrician:—

In the article on Fan Motors for 1902, which appeared in your March number, a statement made in reference to the Hurricane motor is very misleading. The author states that this machine has a field magnet "almost precisely" the same as that of the Holtzer-Cabot motor, and that the bearings are contained in the end-caps which close the openings in the field magnet shell, "as in the case of the Holtzer-Cabot machine." While these statements are correct in themselves, they are unfair to the Hurricane motor, because they give the impression that it is an imitation of the Holtzer-Cabot machine, which is untrue. As a matter of fact, the Hurricane fan motor was the first one built with a single-piece spherical field-magnet structure.

Eck Dynamo & Motor Works.

Belleville, N. J.

[There was no intention to intimate that the Hurricane motor was copied from any other machine, and we should regret very much to have any reader form that impression. The note on page 177 explains the matter thoroughly.—Editor.]

The Size of Telephone Switchboards.

To the Editor, American Electrician:—

I notice in your March number a communication from Mr. William Meyer, under the above heading, in which I am accused of being more visionary than practical in my statements. In reply I wish to state that the Frontier Telephone Company, of Buffalo, N. Y., contracted on March 17 for a switchboard of the latest common-battery relay type, having a capacity of 18,000 lines, specifying in the contract that the vertical distance between the key shelf and the upper row of multiple jacks must not exceed 35 inches. The successful bidder on this board will build the multiple with jacks on 0.3-inch centers, the contract being awarded on samples submitted. Therefore, there is nothing visionary in the fact that an 18,000-line multiple, plus the required number of outgoing-trunk jacks, plus 200 answering jacks and lamps per operator, can be placed within easy reach of the operator. The contracting firm for this switchboard could just as well have built a ¼-inch jack and increased thereby the capacity of the switchboard to 25,000 lines.

By using the four-division switchboard the capacity with a ¼-inch jack could be brought up to 90,000 lines. Where Mr. Meyer is not up to date is that he labors under the supposition that in the present state of the art a four-division switchboard needs polarized drops, kick coils and such apparatus as was installed a few years ago in the 20,000-line exchanges he speaks of. (By the way, Mr. Meyer ought to know how many springs are in the four-push-button boxes he has reference to, as he had a great deal to do with the drawings pertaining to these boxes). To-day the four-division boards are built with common battery and lamp signals exactly like the latest one-division boards, and as far as the subscribers' box is concerned there are neither kick coils nor cranks nor "about half a hundred" springs. All that remains in the box are four push-buttons, each one pressing upon two springs making a contact.

F. J. Dommerque.

Chicago, Ill., March 19, 1902.

NOTES.

National Electric Light Association.—The twenty-fifth convention of this association will be held at Cincinnati, May 20, 21 and 22. The headquarters of the association will be at the Grand Hotel, where delegates will be given rates of $3 a day on the American plan and from $1 a day up on the European plan.

The Penberthy Company Exonerated.—The coroner's jury which spent about ten days investigating a boiler explosion at the factory of the Penberthy Injector Company which caused the death of a number of persons, has rendered a verdict entirely exonerating the Penberthy Company. The jury found that the officers of the Company and the engineer in charge of the boiler had given it proper care and attention, and were not in any way responsible for the explosion. The explosion was attributed to defective material and workmanship in the boiler.

Electromagnetic Cannon in Sweden.—A civil engineering journal states that Professor Birkeland, of Sweden, who two years ago was sent by his government to northern Norway to study magnetism, the aurora borealis, and cloud formations, is engaged in the construction of a cannon with electromagnetism as the motive power in place of explosives. It is further stated that a small model of the invention throws projectiles weighing a pound with great force! From the foregoing it would appear that the Professor's attention was monopolized by the aurora borealis and cloud formations—pipe clouds.

A Swiss Electric Power Scheme.—The city of Zurich is about to utilize the mountain torrents of the country for a great scheme of industrial electric power. With the co-operation of the cantons of Schwytz and St. Gall the Marsby Valley behind Einsiedeln, once the site of a lake 11 miles square, is again to be converted into a lake by means of water from the torrents of Grossbach, Reichenbach and Sihl. The difference of level between the valley and that of Lake Zurich is about 600 ft., and this huge fall will give a force equal to about 60,000 h.p. The work will take three years to complete, and will cost about $8,000,000.

Temperature of the Incandescent Lamp Filament.—The temperature of the electrical incandescent lamp filament has been determined by the celebrated French physicist, Professor Paul Janet, of the Paris Academy of Sciences. To preserve the heat radiated from the carbon filament of a lamp is a matter of great difficulty, since the filament is separated from the atmosphere by a vacuum. Professor Janet has determined from investigations made with four different lamps that the filaments attain a temperature varying from 1610 to 1720 degrees Centigrade.

Summer Meeting of the American Institute.— —The American Institute of Electrical Engineers will hold its annual Summer meeting this year at Great Barrington, Mass., June 18, 19, 20 and 21. The official headquarters will be at the Berkshire Inn, but it is expected that special rates will be offered by all the hotels of Great Barrington. A special train will leave the Grand Central Station, New York, at 7.30 p. m., June 17, arriving at Great Barrington about 10.30. The sessions will be adjourned each day at 1 o'clock, leaving the afternoons and evenings free. On one of the afternoons a visit will be made to the interesting works of the Stanley Electric Manufacturing Company at Pittsfield.

Warning Signals for the Erie Tunnel.—In order to give warning of accidents in the Bergen tunnel of the Erie Railroad near Jersey City incandescent lamps with red globes are to be installed inside the tunnel at intervals of 200 ft. The lamp circuit will be controlled by switches at points 500 ft. apart; any one of these switches will turn on the lights throughout the tunnel. The occasion of apprehension of danger was the falling of a part of the tunnel roof last December. By the simple arrangement mentioned, watchmen patrolling the tunnel can very promptly give signals when trouble occurs. The electric light circuits extend to the signal towers at the ends of the block in which the tunnel is situated.

An Interstate Telephone Association Projected.—At a meeting recently held in Chicago at the Palmer House, the organization of an Interstate Telephone Association was practically consummated and dates set for the completion of this organization and the selection of its permanent officers are April 9, 10 and 11. The meeting in question was called at the request of a large number of representative telephone men throughout Illinois and the states adjoining. In order to make the meeting more attractive, and possibly add to the attendance, a banquet on the evening of April 9, and other entertainments at the expense of those interested were decided upon. From present indications the meeting is going to be a very large one, in all probability larger than any similar gathering. About 5000 invitations will be sent to representative telephone men in Illinois and the six neighboring states. The Sherman House, Chicago, has been selected as headquarters, and reservations can be secured there at reduced rates.

American Electro-Chemical Society.—The movement to form a national society for those interested in electro-chemistry, similar in its nature to the American Institute of Electrical Engineers and the American Chemical Society, has met with even more encouragement than was anticipated. The number of those who have expressed willingness to become charter members has already exceeded 300, so that the organization of the society is assured. The first general meeting, as announced last month, will be held in Philadelphia, April 3, and sessions will be held on April 4 and 5, at which papers will be read and discussed. Visits will be made to places of interest; the chemical works of Harrison Bros. & Co., where sodium is manufactured electrolyticaly, is scheduled for Thursday afternoon; the chemical laboratory of the University of Pennsylvania will be visited on Saturday morning, and arrangements have been made to visit the Bethlehem Steel Company's works, the Lehigh Zinc Works and Lehigh University on Saturday afternoon, by a train leaving Philadelphia at 12.30 o'clock.

Progress in Wireless Telegraphy.—According to press dispatches published in the daily papers, the Marconi Wireless Telegraph Company has made a definite contract with the Canadian Government for the establishment of a wireless telegraph system to give communication between the Dominion of Canada and England. It is stated that Mr. Marconi's chief engineer in Canada, Mr. R. N. Vyvyan, has placed orders for the power plant equipment of a station to be located at Cape Breton, and expects to establish wireless communication between Canada and England by June 1. The apparatus is to be of the latest and most powerful type, of course, and a tower will be erected instead of a pole for the vertical conductor. In this connection it is interesting to note the salutary effect of government ownership upon scientific progress. The Marconi Company is graciously allowed by the British law to establish wireless telegraph stations on the English coast provided the stations do not communicate with each other and thus enter into competition with the government telegraph system, and do not communicate with any ship or station within three miles from the shore line. Efforts are being made to have the law relating to this subject modified.

The Street Railway Association.—The twenty-first annual meeting of the American Street Railway Association will be held in the Light Guard Armory, Detroit, Mich., Wednesday, Thursday and Friday, October 8, 9 and 10, 1902. Papers will be presented on the following subjects: "The Registration of Transfers," "Benefit Associations," "Discipline of Employees by the Merit System," "The Transportation of Light Express and Parcel Delivery," "Steam Turbine Engines," "Signals for Urban and Interurban Railways," and "The Adjustment of Damage Claims." It is expected that there will be a fine exhibition of street railway supplies. Thursday, October 9, has been set apart as a day for the examination of the exhibits. No session of the association will be held, so that all may have ample time for this purpose.

The headquarters of the association will be at the Cadillac Hotel. No rooms will be assigned prior to April 15, the assignment to be made under the supervision of the local committee. Members intending to be present are requested to apply for rooms at once, so there may be no disappointment in this regard. Preference will be given to representatives of members of the association if applications are filed in time. Further information will be furnished by T. C. Penington, secretary, whose address is No. 2020 State Street, Chicago.

A Discussion on Motive Power for Auxiliaries.—In the course of a discussion at the Chicago Electrical Association on March 8, of a paper by George A. Damon and William D. Ray on the Grand Rapids, Holland & Lake Michigan Rapid Railway, the question of steam-driven *vs.* electrically-driven boiler-feed pumps, condenser pumps, draft-fans and other auxiliary appliances about a steam plant was brought up. Mr. Damon expressed his preference for the use of steam-driven auxiliaries exhausting into feed-water heaters. Mr. Damon has been connected with the design of a number of plants using electrically-driven auxiliaries as well as many having steam-driven auxiliaries. He took the ground that while steam-driven auxiliaries are wasteful considered simply from the number of pounds of steam consumed per horse-power-hour, they were by no means so wasteful when a large per cent of the heat passing out of the exhausts of these auxiliary engines is recovered in heating feed-water. The investment is much less for steam-driven auxiliaries because when electrically-driven auxiliaries are used there must be added to the cost of the motor in each case the cost per kilowatt of engines and generating machinery necessary to supply the motor. The question of successfully varying the speed of an electric motor driving auxiliary apparatus is a serious one, and in many cases this cannot be done without the use of wasteful resistance in the circuit. On steam-driven pumps, fans, etc., the speed variation is easy.

This question was fully treated in the editorial pages of the AMERICAN ELECTRICIAN for January, 1902, and the showing based on average practice figures for a non-condensing plant was largely in favor of electrically-driven pumps. For a condensing plant the saving is much smaller.

Fan Motor Construction.—In the fan motor article published last month machines of similar general type or construction were classed together, as usual, and features embodied in one machine, which had previously been described in connection with another, were referred to as being like the features previously described. This course was pursued merely in order to avoid a repetition of descriptions and an unnecesary prolongation of the article, which at best must be unwieldly in length. It has been suggested to us that these statements constitute a reflection on the machines which were referred to as being "similar" or "like" other machines in design or construction, and that such characterization might be construed to mean that the machine thus referred to was an imitation of the one with which it was compared. For example, on page 122 the statement was made that the Bates bracket fan has a field magnet "similar in type" to that of the Western Electric desk and bracket fan; on page 124 it was stated that the Hurricane desk motor has a field magnet of "almost precisely the same design" as the Holtzer-Cabot machine: on page 126 it was stated that the Peerless ceiling fan is similar in general design to the Robbins & Myers machine, and that "the lubrication of the bearings is effected in precisely the same way," etc.; again, on the same page, the Towle desk fan motor was referred to as being somewhat similar to the Peerless machine, and on page 127 the Diehl motor was described as having the same exterior contour as the Paragon machine, but with constructional features somewhat different. In all of these cases the comparisons made were intended to be purely mechanical, and were made for the purpose of classifying the machines as to general type and not with any intention of intimating that any one machine was a copy of any other. This is not true in a single one of the cases mentioned, and we should regret very much to have any reader form the impression that the comparisons were drawn with any such view, or that the order in which the machines were described bears any relation whatever to their precedence in design or other features. It is utterly impracticable to describe the machines consistently throughout the article in the order in which they were designed or put on the market; the sequence in which the descriptions appear is determined chiefly by the mechanical exigencies of the make-up of the pages, and largely by the sequence in which the various budgets of descriptive material are received, the article being written in sections.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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The Metric System.

After an exhaustive hearing of opinions from representatives of the principal industries of the United States, the Congressional Committee on Coinage, Weights and Measures has reported favorably the bill providing for the adoption of the metric system by the United States Government, the enactment to take effect so far as governmental work is concerned on January 1, 1904. On January 1, 1907, the metric system is to become the legal standard throughout the country, but this does not imply that its exclusive use will be compulsory. In order to dispel doubts as to this latter point the committee obtained from the United States Attorney General an opinion to that effect, but it is difficult to understand why there should ever have been any apprehension on that score. Congress has no constitutional power to compel anyone to measure anything by any particular system of units, and the bill contains no provision that can be construed as rendering the present systems of weight and measurement illegal. These facts completely nullify the report of the committee of the American Society of Mechanical Engineers opposing the change, which report, by the way, represented the views, not of the entire Society or even a majority of its members, but of a comparatively small coterie, two of whom have for years manifested bitter prejudice against the metric system. And the opinions of the members of that committee—who are undoubtedly prominent and able engineers—have been amply counterbalanced by opinions from other engineers just as prominent, just as capable, and more progressive. Superintendent Vauclain of the Baldwin Locomotive Works, Vice-President Christie of the American Bridge Company and Elihu Thomson of the General Electric Company, for example, can scarcely be considered novices in the manufacturing line.

Aside from the opinions of anyone, however, an inspection of the arguments advanced against the change to the metric system fails to show any rational adverse claim except that the change will be expensive for manufacturers of standardized machinery, which is a self-evident proposition. Most of the opposition—practically all excepting that from one large manufacturing establishment—has been of the stubborn, unreasoning character that tempts one to attribute it to bigotry pure and simple. One prominent manufacturer, while admitting that a department of his company's factory already has facilities for making gauges and other articles to both the English and the metric scales, and that the employees in that department work as well in one system as in the other "because they are used to it," persisted in claiming that the adoption of the metric system exclusively would be disadvantageous on the ground that a workman grasps the statement of a measurement in inches and fractions more readily than a statement expressed in decimals. In other words, it is more practical to manufacture under two incommensurate standards of measurement than under a single standard, because fractions, which are used in the one, are more intelligible than decimals, which are used in the other!

Reverting to the question of the expense that would be entailed by a change to the metric system, the statement that has frequently been made to the effect that all existing machinery would have to be superseded as rapidly as possible by machines built to metric measurements is without foundation in fact. Planers, shapers, milling and gear-cutting machines, drilling and boring machinery, engine lathes, punching and shearing machinery—in short, the bulk of the equipment of any shop—would not require a solitary change to be made in them, excepting the screw-cutting gears of a lathe. The subordinate (and, we grant, rather expensive) tools, such as taps and dies, jigs, drills, reamers and standard gauges, would need to be replaced ultimately, and many patterns and templates would require modification. New drawings would need to be made as speedily as practicable, and new patterns in some cases, such as those for repair parts, the retention of the old ones being necessary for some years.

A deliciously humorous flavor has been injected into the discussion by the New York *Times*, which for some reason that is far from obvious, has vigorously opposed the change. In a recent editorial (in which, incidentally, the prominent opponents of the bill were quoted while not the slightest reference was made to equally prominent and more numerous advocates), the *Times* refers generally to those favoring the bill as "cranks and theorists." Of course, all those opposing the measure, including the writer of the

Times editorial, are highly practical engineers and experienced manufacturers.

Telephone Exchange Rates.

The telephone industry is just about at the beginning of a period of agitation with regard to rates, very similar to that from which the electric lighting industry is almost ready to emerge. For many years—in fact, up to the time of independent activity—the flat rate was the only method of charging attempted. That this was due to the lack of necessity for graded charges because the rates were high enough to show a profit "regardless," would appear to be a rational conclusion. It should be supplemented, however, with the explanation that prior to the development of the central energy plan, with its beautiful visual signal system and marvelously facile service, the expense of operation per subscriber was more uniform than now. In the earlier days of the magneto system and drop shutter signals only those persons had telephones who actually had to have them, and every subscriber used his instrument to more nearly the same extent than is now the case; consequently, there was less reason for graded or measured rates. As the switchboard system was improved and the cost of operation reduced, permitting lower rates, the use of the telephone extended to persons whose service was less frequent. Continued progression in this direction has brought matters to a point where it is commercially absurd to serve all the subscribers to a good sized exchange at the same rate.

The selection of an equitable and at the same time practical system of service charges is even more difficult in telephony than in electric lighting. A telephone exchange has a much larger proportion of fixed expenses than a central station; measurement of telephonic service, to be logical, should take into account the duration of each conversation, as well as the number of actual connections, which is not nearly so easy as the measurement of the time factor in lighting and power service. Moreover, discrimination between successful and unsuccessful attempts for service must be made. These requirements are fulfilled in long-distance work, where the calls are infrequent and the conversations short, by the supervision of the long-distance operator. But with local calls in a busy exchange this course is impossible, and an operator would have a hard time indeed if she were even required, after connecting two lines, to satisfy herself that the person calling had got the desired person at the called station, and then to connect in an automatic register to record the duration of the conversation. And just fancy the work of transcribing the records and billing for the service!

It is just possible that a solution of the problem may be found in the combination of flat rates for very busy lines, and slot machines for the others, with a small flat charge to cover a certain percentage on the cost of the meter subscriber's outfit and that part of the switchboard equipment connected exclusively to his line. The provision of a slot instrument that would automatically cut off at the expiration of a predetermined period, unless another coin be deposited, would not tax one's ingenuity to the straining point; the machine should, of course, be so constructed as to notify the user, by bell or buzzer, a few moments before the expiration of the period for which payment has been made. Whatever method may be ultimately applied, it must reach much farther than the present crude system of charging a flat rate for a certain maximum number of calls per annum, with an extra charge of so much for each call in excess of that number.

Telephones for Residences.

In view of the highly efficient state to which interior telephone systems have been developed, it is rather strange that architects, builders and owners of private residences and apartment houses do not avail themselves of such systems more generally. The hotel fraternity was quick to appreciate the advantages of a local exchange with telephones in all the rooms and a central switchboard in the office, but the full value of the operatorless systems for residence buildings does not appear to have been grasped.

For ordinary residences, any of the intercommunicating systems, installed on the central energy plan, would serve admirably. A magneto-signal system is not so attractive for this purpose as a battery-call arrangement in which the user merely turns a switch or inserts a plug to connect with the desired station, and then takes the receiver off the hook. For use in the more pretentious class of city residences and in town or country residences of any kind there is no comparison between such a telephone system and an ordinary annunciator and speaking tube outfit. The wiring is only one degree more elaborate than the ordinary annunciator circuits, and the expense of installing this kind of a system is not much greater than that of providing an annunciator and speaking tube outfit, while the manual work of installation is less difficult.

For apartment houses an even less complex system is required than for residences, as intercommunication between the various apartments is not desired. A mere "microtelephone" and bell in each apartment, connected to a central switchboard of the simplest type—a dial switch and ringing key, for example—would answer all requirements in a house not connected with the city exchange. Larger apartment houses, or "family hotels," come in the hotel class, of course, and require a central board with facilities for plugging through to the exchange line. But in the light of telephonic facilities now available, the speaking tube is an obsolete crudity, with no excuse for continued existence in either private or public residences.

Transatlantic Wireless Telegraphy.

The public announcement, noted on another page, of a contract made by the Canadian authorities with the Marconi Company for the establishment of wireless telegraph communication between Canada and Great Britain is quite calculated to take away one's breath. Unless experiments have been made which have not been published and have demonstrated beyond peradventure the practicability of the project, Mr. Marconi would seem to have been rather rash in entering into a contract for transatlantic service. In the absence of thorough preliminary experiments, such a contract would be no evidence whatever of the feasibility of the project, but rather an indication that the previous achievements of this gifted investigator have developed a spirit of reckless optimism or egotism, or both, that is inimical to serious work and progress. Supreme confidence is an excellent quality, but unsupported by exhaustive preliminary experiment it has never yet resulted in success where a considerable departure from established engineering practice was involved. We earnestly hope, however, that the outcome of the new undertaking may fully vindicate Mr. Marconi's claims and justify the faith that the lay and scientific worlds have shown in him, and that we shall find ourselves mistaken in having regarded the project dubiously.

DESIGN FOR AN ELECTRIC MOTOR CYCLE.

BY J. C. BROCKSMITH.

THE MOTOR.

The motor for the tandem described last month is a four-pole machine, having a circular yoke and radial poles of cast steel in one piece. It is provided with cover plates cast of aluminum or any of its alloys, of which there are now in use several that are suitable for this purpose. It is further provided with a self-contained back-gear, the countershaft of which passes through the motor from end to end inside the field magnet frame, and is supported in bearings on the cover plates. All bearings in the motor are of the steel ball type, in order to reduce friction and wear to a minimum, and the winding is of the ordinary series type.

The motor has been designed especially with a view to large overload capacity, and to this end a considerably greater cross-section in copper and in brush surface has been provided than would ordinarily be considered necessary, even in an enclosed motor. Also the magnetic field at normal load is of moderate density and capable of a considerable increase in strength before reaching practical saturation. The result of this construction is that the motor is able to meet overloads by giving a greatly increased torque when the speed becomes reduced, without, however, demanding increased current in the same proportion. In other words, the torque will vary almost with the square of the current instead of approximately in simple proportion to the current, as it would in a motor working with saturated field at normal load.

Fig. 2 shows an end view of the motor with the cover plate over one portion represented as cut away to bring out the construction and details of the armature core and pole-pieces and the arrangement of the field coils. The armature core is 4 ins. in diameter, and has 24 slots 9/32 in. wide and 9/16 in. deep. The teeth are of the ordinary straight form, and there should be a slight fillet at the bottoms of the slots (about .04 in. radius) to strengthen the roots of the teeth. The armature is of the usual laminated construction, and the discs are to have a 1-in. hole in the center and a 3/16-in. key way.

The circular yoke of the field frame is of the dimensions indicated on the drawing. The poles are cast in one piece with the yoke and are bored to a diameter of 4 3/32 ins. No pole-shoes are used, the field coils being simply slipped over the poles and retained in position by means of wooden wedges. At four points around the circular yoke holes are drilled and tapped with a 16 thread for the ⅜ x 2¼ cap screws, which serve to fasten the bearing shells to the field frame.

Fig. 2-A shows an end view and section of the bearing shell or cover plate. It consists, briefly, of a curved shell which covers the field coils and is bored for a short distance on its inner surface to fit over the turned portion of the steel field yoke. In the center is a large circular opening of about the same diameter as the armature, and at the center of this opening is seen the case for containing the ball armature bearings. This is supported from the walls of the shell by means of four radial arms, and these at the same time serve to support the brush-holders, for which purpose they are drilled with 7/16-in. holes.

Fig. 3 is a sectional plan of the complete motor, which shows, perhaps more clearly than any of the other views, all the details and general arrangement of the working parts of the motor. This view brings out the countershaft and gearing arrangement, the bearing construction, the commutator and brush-holders, and the location of the driving sprocket at the commutator end of the machine. The armature and field cores, it will be noted, are 2½ ins. long and the yoke of the frame is 4 ins. in length, the pole-pieces being set out of center with respect to the yoke about ⅝ in., which

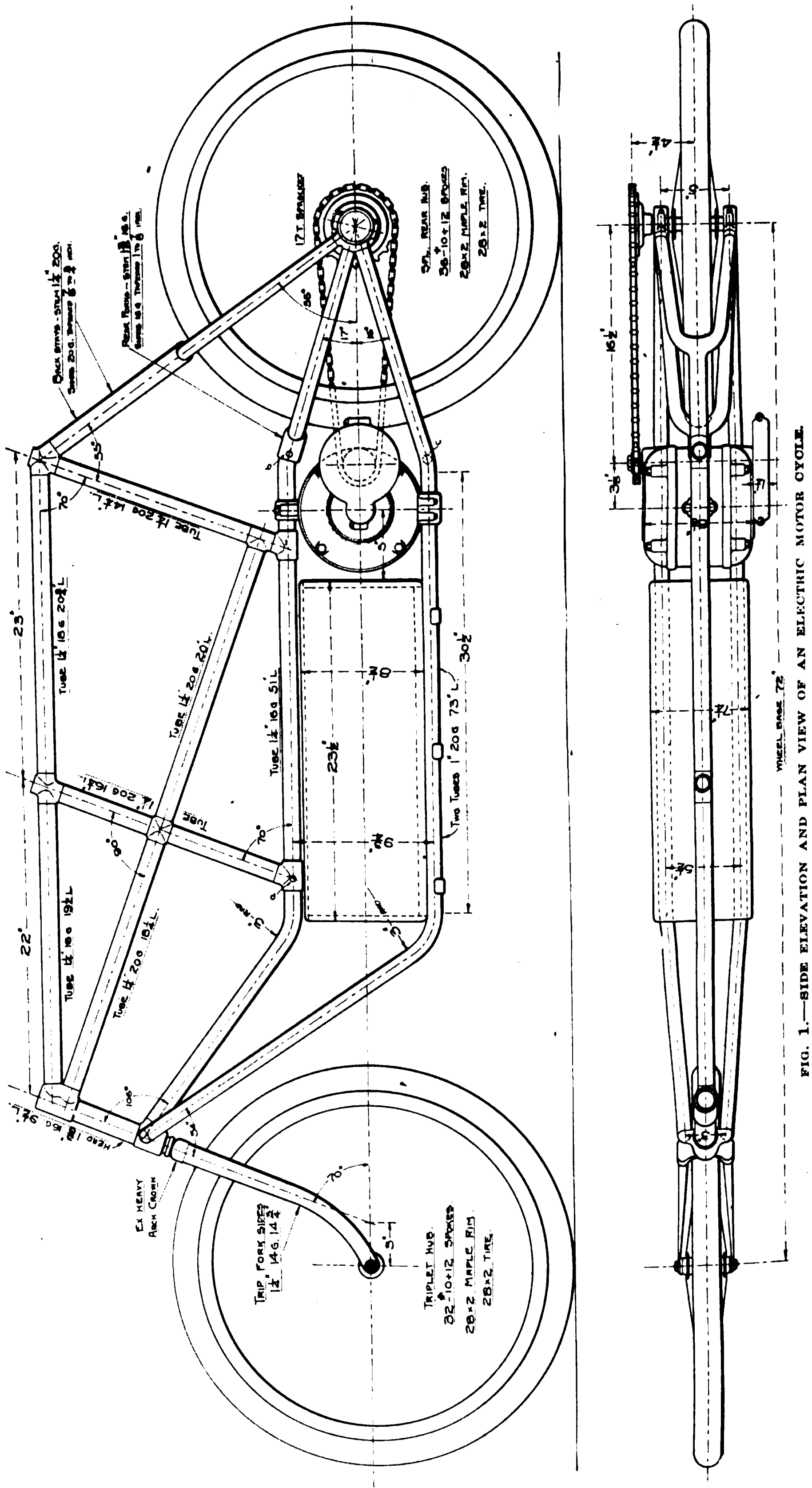


FIG. 1.—SIDE ELEVATION AND PLAN VIEW OF AN ELECTRIC MOTOR CYCLE.

allows the necessary space at one end of the frame for a commutator of ample size, and also enables the builder to use cover plates which are the same at both ends. The cover plates are alike in all respects except that the lugs provided for clamping the machine to the reaches will require to be displaced 180 degrees on the one end from their position at the other end. This difficulty is overcome by making the lug, which is shown at the *bottom* in Fig. 2-A, a detachable piece on the pattern, and after casting one plate with this arrangement removing the piece and fastening it to the *top* of the pattern. In this way castings which are rights and lefts can be obtained from the same pattern by making the slight changes indicated.

The large central opening in the shell, however, is to be bored and threaded to receive some discs which are screwed in, thus enclosing the motor completely. In Fig. 3 such discs are shown in position. As a material from which to cast these cover plates an alloy of aluminum and zinc is recommended, consisting of two parts of aluminum and one part zinc. Pure aluminum is soft and difficult to work with machine tools, while the alloy just described works freely and has the further advantages of being stronger, stiffer, and less expensive than the pure metal. This metal is termed "alzinc."

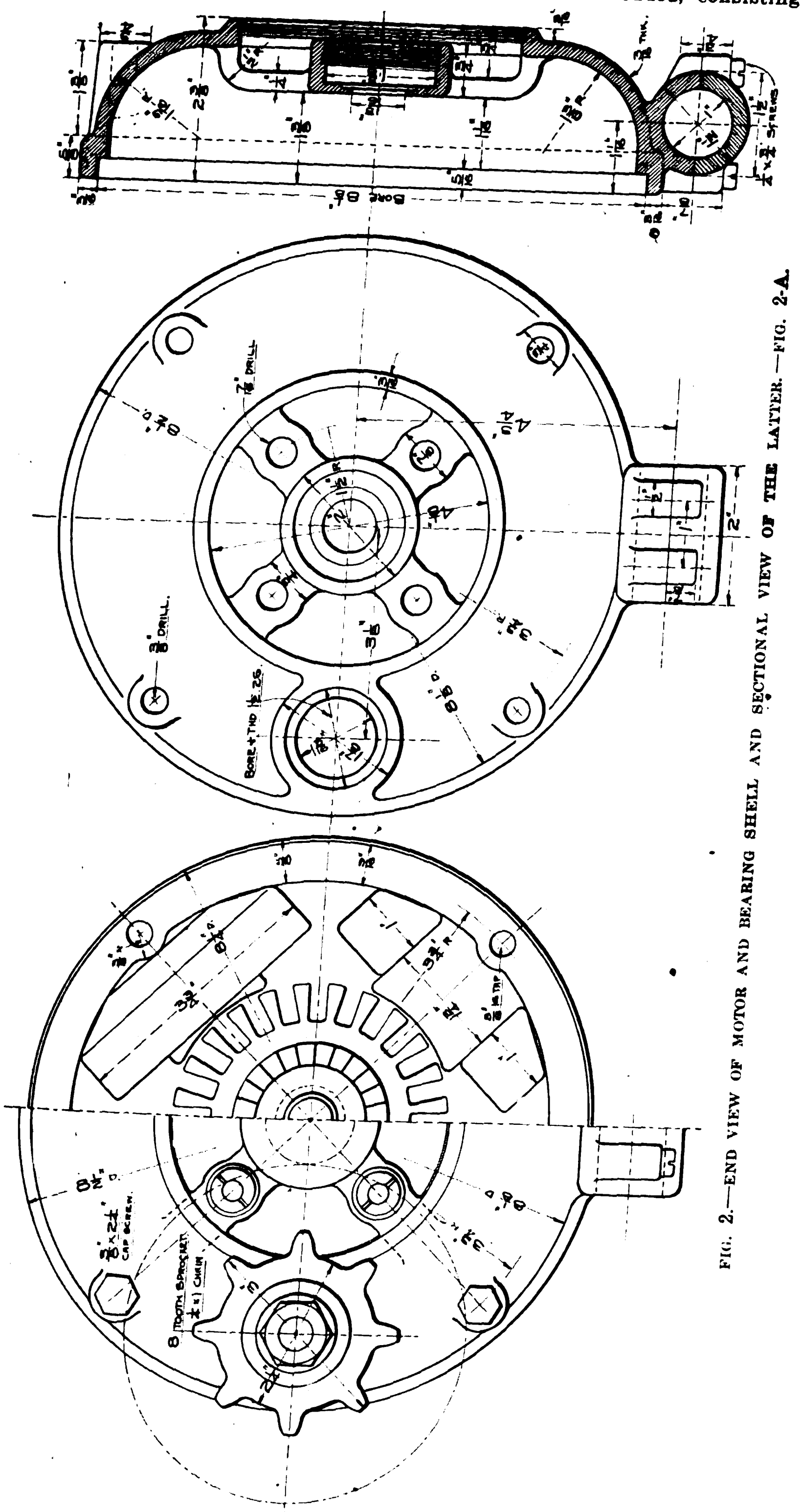


FIG. 2.—END VIEW OF MOTOR AND BEARING SHELL AND SECTIONAL VIEW OF THE LATTER.—FIG. 2-A.

The case for containing the ball bearings is to be bored and threaded to suit the steel races. The bore for this case should, of course, be exactly concentric with the finished portion at the back of the shell, which fits the field frame. A boss is provided at one side, located 3⅛ ins. from the armature shaft center, which is to be bored and threaded 1½ ins., 26 threads per inch, for receiving the tool steel cups shown in Fig. 3. Great care is necessary in setting up the work for this operation, in order that the bore of this boss shall be exactly 3⅛ ins. from center to center of the armature bearings. Upon the accuracy of this work will depend the proper meshing of the gears.

At the bottom of the cover plate there is provided a lug cast in one piece with the shell, which is to be cored with a 1-in. hole. The lug can afterward be sawed into halves and the cap fastened on by means of four machine screws. It is not necessary to bore this lug, as it merely serves to clamp the motor to the reach tubes, which are 1 in. in diameter, and a hole cored to size will be sufficiently accurate for this purpose.

In finishing the field magnet frame, it is bored out and the ends of the circular yoke faced off; the outer surface of the yoke also is trued up for a distance of about 5/16 in. from each end, making the diameter of this portion 8⅛ ins., and care must be taken to have it true with the bore. The armature bearings are "grooved shaft ball bearings" for ⅝-in. shaft. The bearings on the countershaft are of the cup and cone variety, giving three points of contact. Mechanically these are not so good as the others, but on account of the slow speed at which the countershaft operates (300 r.p.m.) and the fact that it does not transmit a very large amount of power, the bearings will be found sufficiently accurate, and they have the further advantage of being considerably less difficult to construct and adjust. All motor bearings have ¼-in. steel balls, 12 in each set.

Fig. 4 shows the details of armature and countershaft, the nuts for the threaded ends of same, the tool steel cups for the countershaft bearings, and the cast-iron discs for the armature core. The armature shaft is to be turned from a length of 1-in. machine steel; the center portion will then not require turning if the piece is accurately centered. A 3/16 in. key is provided to match the seat in the core discs and shaft, and the discs are compressed between the two cast-iron flanges by outside means. The two flanges are secured to the shaft by means of 3/16-in. steel pins driven through holes provided in their hubs and also in the shaft. At the bearings the armature shaft is to be turned a tight fit for the tool steel spools, and these are pressed on only after all other work on the armature has been completed. The driving end of the armature shaft is turned taper and keyseated to receive a steel pinion.

The countershaft is made from a piece

of 1⅛-in. annealed tool steel; it is to be finished to the sizes shown and then the portions which form the cones of the bearings are to be hardened. Care should be taken not to heat any more of the shaft than is absolutely necessary to accomplish the desired result, as it is important that the shaft shall run true after being tempered. At the right of the sketch will be seen one of the tool steel cups which are used in the countershaft bearings; they are 1½ ins. outside diameter and threaded 26 threads per inch. Small holes should be provided in the face of each cup for a spanner wrench to be used in adjustment of the bearing. It is probable that the cups of this description can be procured ready made, in which case the builder would be spared the not inconsiderable labor of making them.

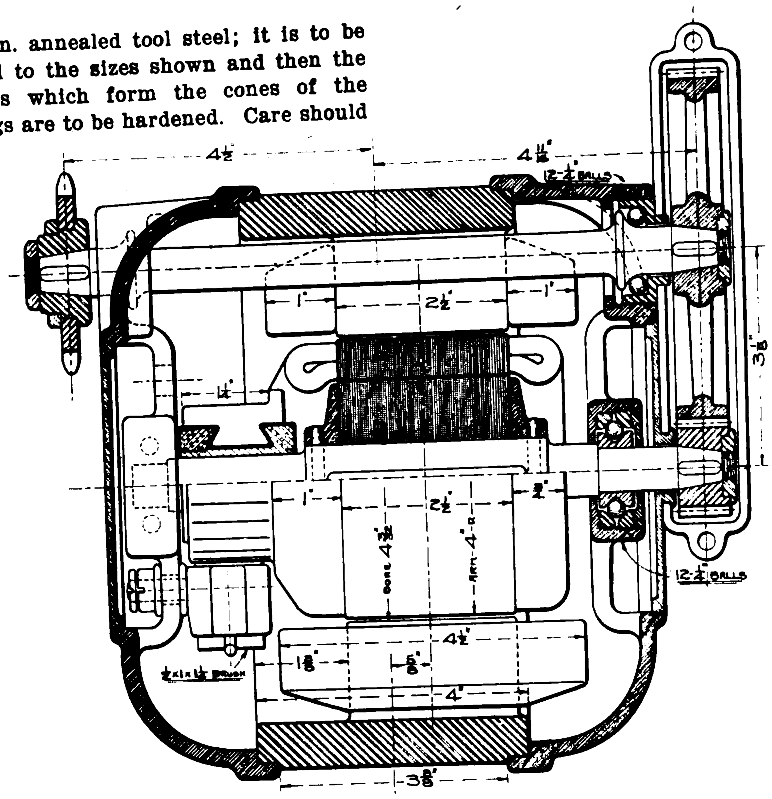


FIG. 3.—SECTIONAL PLAN OF COMPLETE MOTOR.

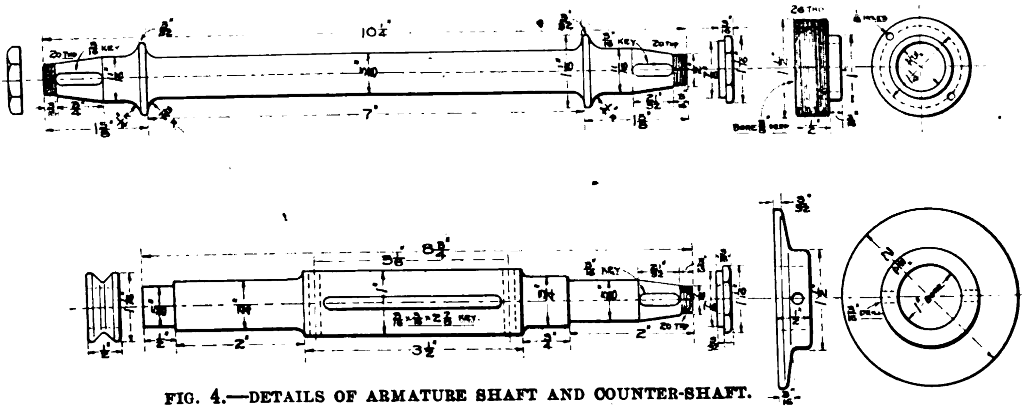


FIG. 4.—DETAILS OF ARMATURE SHAFT AND COUNTER-SHAFT.

The driving sprocket, which is keyed to the end of the countershaft, is an ordinary 8-tooth sprocket for 1-in. pitch ¼-in. chain. These sprockets are usually supplied with a 1¼-in. to 1 5/16-in. hole threaded right-handed to 24 pitch, and a lock nut threaded left-handed to the same pitch. This being the case, it will be necessary to turn a hub of steel, threaded on its periphery to suit the sprocket and bored out to fit the tapered end of the shaft. Such an arrangement is shown in Fig. 3.

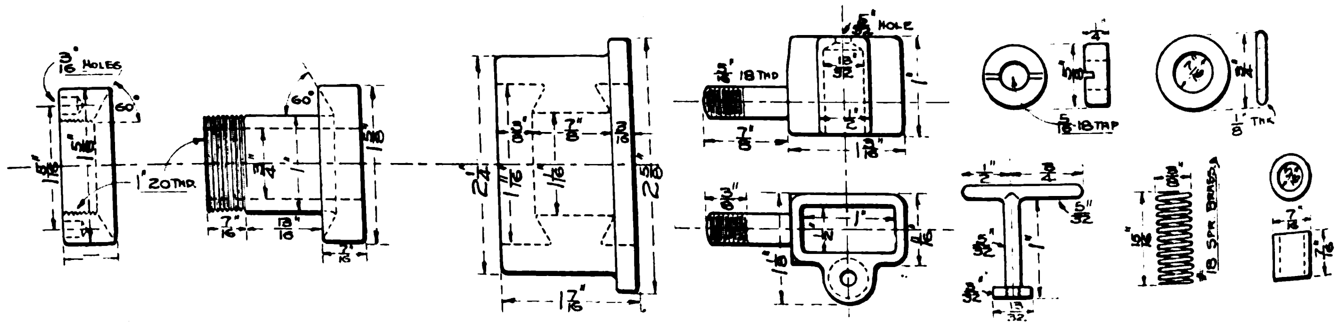


FIG. 5.—DETAILS OF COMMUTATOR, BRUSH-HOLDER, SPRINGS, AND INSULATION FOR SAME.

The commutator has a 1¼-in. face, and four brushes are mounted to bear at equidistant points around it. The brushes are of the radial type, and should be of graphite or plumbago; their dimensions are ½ in. thick, 1 in. wide, and 1¼ ins. long. Fig. 5 shows the details of the commutator, brush-holders, and springs and insulation for same. The commutator can be most easily constructed from a copper casting turned to the sizes shown, and then sawed in 24 equal segments by means of a No. 23 screw-slotting cutter mounted on a mandrel in the lathe. The segments thus obtained are then built up with mica insulation and are clamped permanently in the brass sleeve and nut shown, which have flanges undercut 60 degrees.

The brush-holders are of brass, and although quite simple in construction, some care will be necessary in finishing them in order to secure the best results, particularly in filing out the slot; the sides should be parallel and the brush should slide freely in the holder, but without lost motion. The springs should be the lightest that can be used and still have sufficiently good contact between brushes and commutator. The spring shown in the drawing will give good results if properly adjusted for length. Either spring brass or phosphor bronze is a good material from which to make the springs. The small brass pressure finger that transmits the pressure from the spring to the brush is provided with a round cross piece which bears on the top of the brush. The brush should have a half-round notch filed across its top end to engage this piece and prevent it from turning and leaving the brush free to fall out of the holder.

The insulation for the brush-holders consists of eight washers of red fibre ¾ in. in diameter and ⅛ in. thick, with a 7-16-in. hole in the center; four small fiber sleeves also are necessary. For fastening the brush-holders in their supporting arms two round brass nuts are shown; eight are required. These are tapped to fit the end of the brush-holder stud, and for convenience in tightening them they are slotted instead of having the usual hexagonal form, which would be difficult to use in this particular case. Four of the nuts should be ¼ in. thick, and the other four, which are to serve as lock nuts and for fastening the electrical connections to the brush-holders, may be thinner, say about ⅛ in. thick. Such an arrangement is shown in Fig. 3.

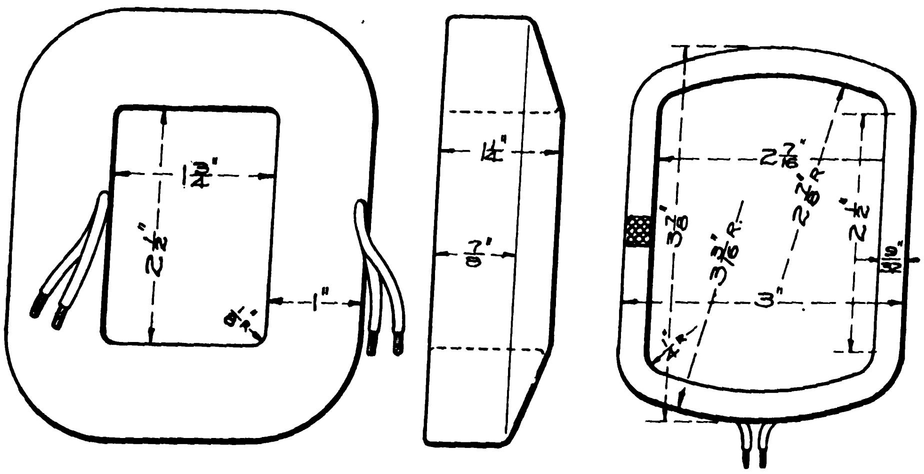


FIG. 6.—FIELD AND ARMATURE COILS.

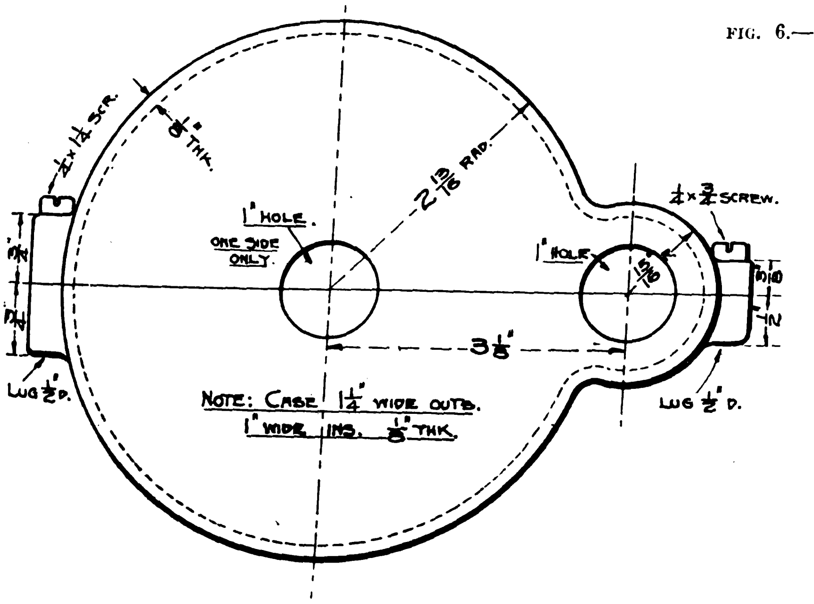


FIG. 7.—GEAR CASE.

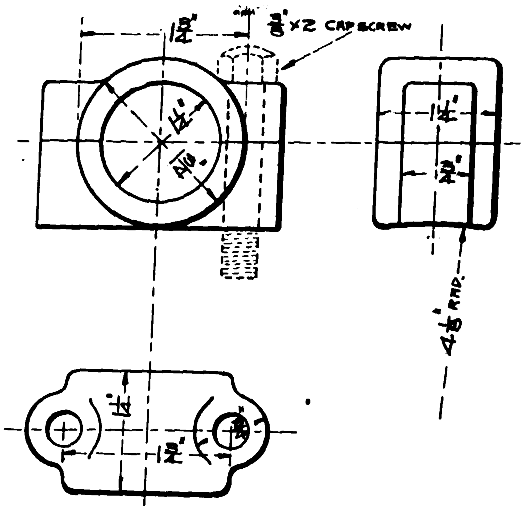


FIG. 9.—"ALZINC' FITTING FOR CLAMPING MOTOR.

Fig. 6 shows the outlines and dimensions of the field and armature coils. Both are to be form-wound, taped, and finally placed in position. The field coils should be wound with 56 turns of No. 8 double cotton-covered magnet wire, wound to the dimensions shown. Since No. 8 wire is rather stiff, and difficult to wind into small coils such as this, No. 11 wire may be used instead, winding two No. 11 wires side by side and connecting them in multiple outside the coil. The coil should then contain 112 turns of No. 11 wire, which, considering that two wires are in parallel, makes 56 turns of conductor equivalent to No. 8 in cross-section.

The armature coils are to be wound with 9 turns of No. 14 double cotton-covered wire 3 turns wide and 3 turns deep. After being taped, one side of the coil is twisted upon itself through 180°; this does not change the general shape or outline of the coil, which remains as shown in the figure, but it has the effect of twisting the curved portion of coil which lies outside the core in such manner that a wire lying at the bottom on one side of the coil will appear on top on the other side. When the coils are assembled on the core the exterior portion of the coils will form a more compact head than can be obtained without twisting. The terminals of the armature coils are to be brought out in the position shown; they will then pass straight out to commutator segments, the two terminals connecting to adjacent segments. This, of course, makes a parallel lap winding, and the point of commutation is at or near the center line of the poles.

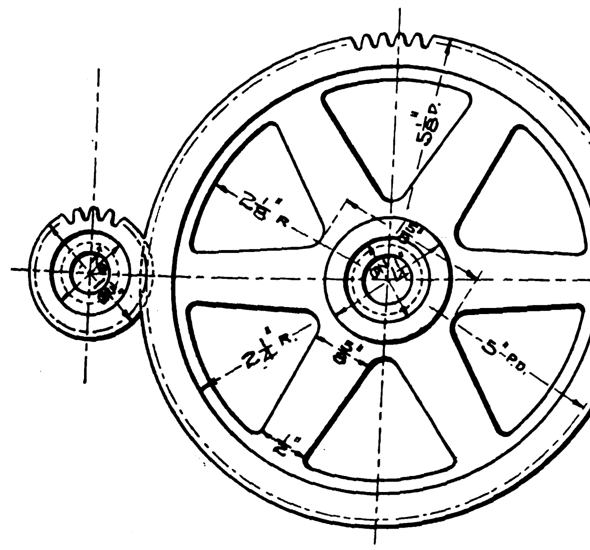


FIG. 8.—VIEW OF MOTOR GEARS.

Figs. 7 and 8 show the gear case and gears for the motor. The pinion is to be made of steel, bored taper, and keyseated to fit armature shaft, and cut to 16 pitch, with 20 teeth. The gear may be made of cast iron, or perhaps "semi-steel," and is cut to 16 pitch and 80 teeth. It will be seen that this makes the gear ratio from armature to countershaft 4, and the ratio from countershaft to rear wheel being 17 : 8, the over-all gear ratio is therefore 8½. When the machine is running at the rate of 12 miles an hour the motor armature will be making 1220 r.p.m., which is its normal speed. The face of both pinion and gear is ¾ in.

The gear case is to be cast in "alzinc." It is, of course, parted along its center line and the halves are fastened together by means of screws. The case is ⅛ in. thick all over and on one side two holes are bored, 1 in. in diameter and 3⅛ ins. between centers. When the case is placed in position on the motor, these holes fit over projections provided at the armature and countershaft bearing, thus supporting the case free from the revolving shafts. Fig. 3 shows this arrangement. The case is, of course, to be filled with a heavy oil or grease for lubricating and silencing the gears. When thus operated it will be found that the gears are practically noiseless, if, of course, they have been accurately cut.

In placing the motor on the tandem frame it will be necessary to turn the machine slightly about its axis, so that the lugs at the bottom of the case will clear the reach tubes while it is being slipped between the upper and lower tubes of the frame. For clamping the motor to the top tube a special fitting of "alzinc" is required, which is shown in detail in Fig. 9. This is shown at the top of the motor in Fig. 1. Two holes are drilled and tapped in the steel yoke for fastening this piece by means of cap screws. For bringing out terminals from the motor, two holes about ⅜ in. in diameter may be drilled through the steel yoke on the side opposite to the countershaft. Some short lengths of flexible rubber-covered cable equivalent to at least No. 6 or No. 8 line wire may be drawn in through these holes and soldered to the terminals inside the frame.

The chain is placed on the sprockets and its tension adjusted by sliding the motor backward or forward on the tubes, finally clamping it in position by tightening the screws at the top and bottom.

The following is a brief summary of the general dimensions of the motor and data for winding:

SUMMARY.

Normal input, 20 volts, 15 amperes. Efficiency, 70 to 72 per cent. Speed, 1200 r.p.m. Steel yoke frame, 8¼ ins. diam. x 4 ins. long, and ⅝ in. wide. Poles, 1¾ x 2½ ins. Armature core, 4 ins. diameter, 2½ ins. long; 24 slots, 9/32 in. wide x 9/16 in. deep. Winding: 24 coils No. 14 wire, double cotton-covered, 9 turns per coil; 18 wires per slot. Allowance for insulation of coil: 30 mils all around. Total conductors on armature, $18 \times 24 = 432$. Specific cross-section of armature wire, 1100 circ. mils per ampere at normal load.

Total lines of force per pole at normal load, 370,000. Induction density at normal load: Armature core, 46,000; air-gaps, 43,750; armature teeth, 122,000; field yoke, 74,000; magnet cores, 84,500.

Ampere-turns required per coil, 850. Calculated number of series turns $= \frac{850}{15} = 57$; actual turns per coil, 56. Specific cross-section of field wire, 1100 circ. mils per ampere at normal load.

Gear ratios: motor to countershaft, 4; countershaft to axle, 2⅛; armature to axle, 8½. Speeds at 12 miles an hour: Rear wheel, 144 r.p.m.; countershaft, 305 r.p.m.; armature, 1220 r.p.m. The battery will be described in a succeeding article.

Shafting Lubrication.—When fitting up an engine shaft or other large shaft, it is a good plan to allow a little end play in the shaft, as it distributes the oil and makes the bearing much smoother and better.

BOILER CORROSION.

BY H. C. LINCOLN.

Among the principal causes which tend to shorten the life of a boiler are corrosion and incrustation. The first of these is a chemical action; the second is mechanical. The quality of the feed water is an important factor in connection with both of these, for if it is impure it may injure the plates by corrosion or it may deposit a sediment which, under certain conditions, will form scale. Water which is free from air and carbonic acid has no bad effect on iron, but all natural water contains air in solution and also a small amount of carbonic acid. Water containing gases or acids in any quantity attacks iron freely. Corrosion may be both external and internal. The first is caused by exposure to the weather, moisture from the ground, or leakage from valves or fittings. Boilers which are set in brickwork are liable to external corrosion, as the masonry tends to hold any moisture that comes in contact with the plates.

Internal corrosion may take place in various ways, such as general corrosion or wasting, pitting or honeycombing and grooving. General corrosion and pitting are due to the chemical action of the feed water, while grooving is the result of both chemical and mechanical actions. General corrosion is difficult to detect, as it acts uniformly over a large surface; this is especially so when the rivet heads waste equally with the plates. The water may attack the plates only at the water line or the action may in some cases be confined to a belt 6 or 8 ins. wide at the water level. Often a seam will be in perfect condition, with the exception of a few rivets or small sections of the plates themselves. The stays or braces are usually weakened more rapidly than the shell plates.

The uncertain action depends principally upon the specific gravity of the corrosive agents, the variation of temperature and the difference in structure of the iron. The only reliable way to determine the amount of wasting is to drill through the plates, plugging them afterward. If the thickness is found to be reduced, the pressure carried by the boiler should be lowered in the same proportion. Pitting is easily detected by examining the edges of the holes, from which the depth and extent are readily determined. Pitting occurs in the form of small patches varying from ½ in. to 12 ins. in diameter; they are sometimes round and sometimes have an irregular shape. When the holes are small and close together it is called honeycombing. The reason for pitting is thought to be due to the difference in structure of the iron, otherwise corrosion would take place equally over the entire surface.

The cause of grooving is not always apparent, but is usually due to the springing of the plates, aided by local corrosion. The distortion of the plates may be caused by improper staying, which allows them to spring back and forth with the varying steam pressure. It usually occurs on the heads around the edge of the angle iron or in the root of the angle itself. Too rigid staying of the ends, or too great a difference in the expansion of the tubes and shells, is almost always sure to cause grooving. Internal grooving is often caused by excessive calking, which injures the surface of the metal and exposes it unduly to the action of the corrosive elements in the feed water. Grooving has the appearance, sometimes, of a fine crack or fracture and may extend into the metal for a considerable distance, even when it shows only as a fine line at the surface. On account of the minuteness of the cracks they are hard to discover, and when once formed enlarge rapidly from the effect of any acidity in the feed water.

When possible, the feed water supply should be changed as soon as internal corrosion is discovered; such a change, after corrosion has begun, will often prolong the life of the boiler. Sometimes it is cheaper to provide a new boiler at regular intervals than to change the water supply. This is not to be recommended, however, for there is often a tendency to use the boiler as long as possible, even after it has become unsafe. When the feed water is acidulous, this is sometimes neutralized by adding soda or soda-ash before the water enters the boiler; the amount to be used depends upon the acidity of the water. If there is much salt present in the feed water, soda should not be used.

Hard scale or incrustation is formed by the accumulation of sediment from the feed water which is left in the boiler, either by evaporation or precipitation. Unless blown out at frequent intervals, the sediment becomes hardened and forms scale. The amount of solid matter in average feed water varies from 20 to 40 grains per gallon; its injurious effect, however, does not depend so much upon the quantity as the nature of the substance. Where proper care is given to blowing off the boiler, the presence of a certain amount of carbonate or chloride of lime would not be objectionable, while the same amount of other salts might cause much trouble.

Feed water is of two kinds, known as "hard" and "soft." The first contains lime in solution, while the last is nearly free from solid matter. The carbonates of lime and magnesia are held in solution by an excess of carbonic acid, so that when the water is heated and this gas is driven off, most of the carbonates are precipitated in the form of a light gray mud. As the temperature of the water increases this sediment becomes less soluble, until at the boiling point it is practically insoluble. If the carbonates are free from other impurities they may be washed out of the boiler after cooling; if organic matter, sulphate of lime, or oil is present, the deposits are likely to become hardened. The action of sulphate of lime is similar to that of the carbonate and is precipitated when the water is heated, precipitation occurring at a higher temperature than in the case of the carbonate, and being practically complete at about 280°.

If a little soda or soda-ash is mixed with the feed water carbonate of lime will be precipitated and may be blown out. The soda should first be dissolved in water and then introduced with the feed water. The proper amount will vary in different cases and can only be determined by experiment. An excess is likely to cause foaming, and often forms a coating on the inside of the water glass. Sulphate of lime causes a hard crust, while the carbonates are soft and granular, and of a grayish color. Sal ammoniac is sometimes used to break up lime compounds, but it is not to be recommended for all cases, as it may form free chlorine gas, which acts upon the plates. If the water contains iron the incrustation is given a reddish color. Brackish water containing chloride of magnesia is also injurious, for when heated there are formed magnesia and hydrochloric acid, which rapidly corrode the plates.

When the condensation from exhaust steam is returned to the boiler, either from a heating system or a surface condenser, there is liable to be a small quantity of oil brought into the boiler, even when special pains are taken to prevent it. A deposit of oil mixed with other impurities is a poor conductor of heat, and overheating or burning of the plates is likely to occur from this cause. A very thin coating of scale may be considered an advantage, as it protects the plates from corrosion, but a thick scale is objectionable, as it is a non-conductor of heat and, as already stated, is liable to produce overheating of the plates. Although the exact amount of heat loss due to scale on any heating surface is not known, it has been stated that a layer 1/16 in. on the tubes of a multitubular boiler results in a loss of 15 to 20 per cent in the increased cost of fuel, and this loss increases rapidly with the thickness of the deposit. An even coating on any surface is less harmful than irregular deposits. Overheating is usually caused by a scale composed of carbonates of lime and magnesia; this occurs in the form of a light powder and is held in suspension or covers the surface of the water as a scum. When this becomes mixed with oil it offers considerable resistance to the rise of the bubbles of steam. In some cases this is sufficient to form a layer of steam next to the plates and lifts the water away from them. As steam is a poor conductor of heat, the plates are liable to become seriously overheated when this occurs.

Incrustation may be prevented in three ways; first, by precipitating the scale-forming substances before the feed water enters the boiler; second, by removing the sediment before it becomes hardened; and third, by removing the hard scale from the interior of the boiler.

Water may be purified to a considerable extent by passing it through some form of purifier before it is fed into the boiler. In some forms the cold water is discharged over a series of trays in an enclosed chamber filled with exhaust steam. The water in falling from one tray to another mixes with the steam and becomes heated. The carbonic acid is driven off by the rise in temperature and the carbonates are precipitated in the pans and also upon a coke filter placed in the bottom of the chamber. A surface blow-off is provided in this type of purifier, so that organic matter or other impurities which rise to the surface may be blown off from time to time. The trays may be cleaned and replaced, but the filtering material should be changed at frequent intervals or as often as found necessary. The Cochrane, Webster, Hoppes and other purifiers of this type act on this principle, although the last named has no filter attachment. The precipitation of scale formation and the neutralization of acids in the feed water are accomplished to a greater or less degree by various chemicals. Soda, in the form of carbonate, soda-ash or caustic soda, is probably the agent most commonly used. When soda and sulphate of lime are mixed sulphate of soda and carbonate of lime are formed; the first of these is soluble and the last is precipitated. If caustic soda is used, it should not be too concentrated or it will itself attack the plates. Potash, chloride of barium and tannic acid are also used, but soda is the most common.

The easiest way to remove the impurities from a boiler after they have been deposited is by blowing off a portion of the water; those which remain in suspension and float at the surface of the water may be discharged through the surface blow-off, a common form of which consists of a flattened cone of sheet metal extending nearly across the boiler and turned so that the currents will deposit solid matter in its mouth. The valve connected with this should be opened frequently to blow out all impurities which may collect on the surface of the water. The loss of heat caused by blowing out a large quantity of water is considerable; indeed, it has been stated that it is greater than that caused by the scale. In the case of lime and magnesia the blow-off cocks should be opened frequently, about once an hour on an average.

The formation of scale is less rapid in water-tube boilers than in the fire-tube, owing to the more rapid circulation of the water. The sediment is swept through the tubes and shell until it enters the mud drum, from which it is blown off.

There are various methods for removing scale that has already formed. A safe method, but one which requires a good deal of time, is by chipping it off with suitable tools; this, however, becomes difficult when the scale is hard or the construction of the boiler complicated. If the chipping is not carefully done, the surface of the rivets or plates may be injured or broken; then the next formation will adhere more closely and any corrosive element in the water will act more rapidly than before. Another method of removing the scale is by sudden expansion and contraction of the plates. This is accomplished by blowing off and then admitting a large volume of cold water, or by cooling down as quickly as possible after the fire is drawn.

These processes will generally loosen the scale in large pieces, so that it can be easily removed, but are extremely harmful to the boiler and are not to be recommended for general practice. A better method is to cool the boiler down as gradually as possible and allow it to stand full of cold water for a few days. In this way the deposits are kept from baking on the plates and the sulphate of lime will be re-dissolved to some extent in the cold water. When the boiler is emptied, the interior should be thoroughly brushed out. The table below gives in a condensed form the causes and remedies for common corrosion and incrustration.

Trouble.	Cause.	Remedy.
Corrosion.	Chloride and sulphate of magnesium.	Carbonate of soda.
	Acid.	Alkalies.
	Grease.	Carbonate of soda. Filter; use mineral oil.
	Carbonic acid and oxygen.	Hot feed water; soda or slaked lime.
	Organic matter.	Precipitate with alum and filter.
	Sulphate of lime.	Carbonate of soda.
	Carbonates of lime, magnesium and iron.	Hot feed water; soda, lime or magnesia.
Incrustation.	Sediment and mud.	Blow-off or filter.
	Any soluble salts.	Blow-off.
		In general, kerosene, chipping, etc.

Novel Method of Driving Exciters.—The Bay Counties Power Company employ a novel method of driving the exciters in their power house. Exciters driven from the main generator are open to the objection that any drop in speed of the main generator causes the exciters to drop in voltage, and this in turn lowers the voltage delivered by the generator exactly at the time when, if anything, increased voltage is needed; consequently the company adopted the following method: A 50-h.p. exciter is driven by a 50-h.p. impulse wheel. Coupled directly to the other end of the water-wheel shaft is a 50-h.p. induction motor. This motor is connected directly to the 2400-volt bus-bars of the station. The water-wheel of the exciter is run with its valve open as for full load at all times. When less than full load is on the exciter the induction motor acts as a generator, delivering energy to the main bus-bars. If the water-wheel for any reason is interrupted on the exciter water-wheel, the induction motor drives the exciter as though nothing had happened. This method of driving exciters has been found very satisfactory.

COMMON BATTERY MULTIPLE TELEPHONE SWITCHBOARD SYSTEM.

BY E. T. EVANS.

The common battery or central energy telephone system described in the present article was installed in a city within the last two years by one of the independent telephone manufacturing companies, and is now in successful operation. Later systems installed by the same company differ slightly from the one illustrated here, which was devised by Mr. F. W. Dunbar. The principle of the line circuit is clearly illustrated by the simple diagram shown in Fig. 1. With the subscriber's receiver in its normal position on the hook, *H*, line 2 is connected through the subscriber's bell to the ground, G_1; the earth forms the return circuit when the operator rings the subscriber's bell. When the subscriber removes the receiver from the hook, the receiver and transmitter are connected in series across the two line wires and the ground connection is broken at the subscriber's station.

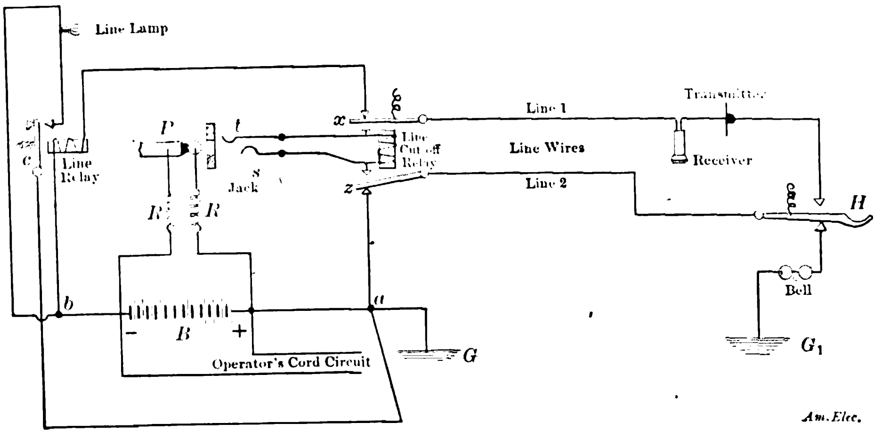

Line Lamp
c
Line Relay
P
t
s
Jack
x
z
Line Cut-off Relay
Line 1
Line Wires
Line 2
Transmitter
Receiver
H
Bell
G1
R
R
b
a
B
-
+
Operator's Cord Circuit
G
Am. Elec.

FIG. 1.—DIAGRAM OF CONNECTIONS, DUNBAR SYSTEM.

At the exchange the two line-wires connect to the levers, *x* and *z*, that are controlled by the so-called line cut-off relay. Normally these levers are not attracted by the magnet of this relay and hence the line wires are connected together through *x*; line relay; point *b*; the common battery, *B*; connection, *a*, back to *z*. Hence, when the subscriber removes the receiver from the hook, the line circuit is closed through the receiver and the transmitter, thereby allowing sufficient current to flow to energize the line relay. The line relay then attracts its armature, thereby closing a circuit from the battery, *B*, through the line lamp, which glows and notifies the operator that a connection is desired by that particular subscriber. When the operator, in answering the call, inserts the plug, *P*, in the spring jack, current flows from the common battery, *B*, through two coils, *R R*, on a supervisory relay, the tip and sleeve of the plug *P*, the tip and sleeve springs, *t* and *s*, respectively, of the answering jack, and the coil of the line-cut-off relay, thereby energizing this relay, which attracts the two levers, *x* and *z*, and thus connects the two line wires to the tip and sleeve strands of the operator's cord circuit. The operation of the line-cut-off relay opens the circuit through the line relay and thereby extinguishes the line lamp.

Fig. 2, which is lettered as nearly as possible like Fig. 1, shows the complete connections for one line circuit. Theoretically, the connections shown in this figure are exactly the same as those shown in Fig. 1, except that the line pilot lamp circuit has been added in Fig. 2.

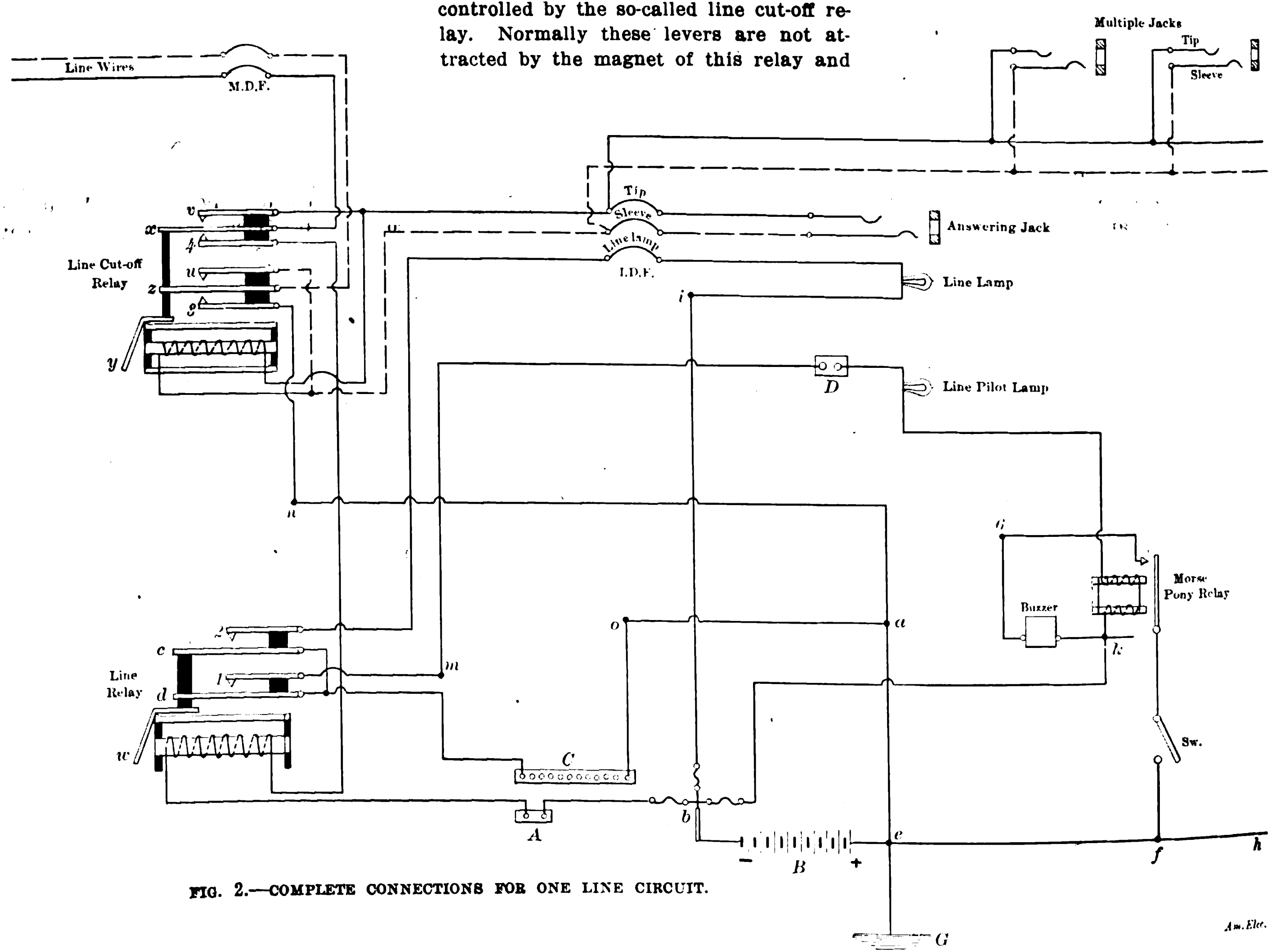

Line Wires
M.D.F.
Multiple Jacks
Tip
Sleeve
v
x
4
Line Cut-off Relay
u
z
3
y
Tip
Sleeve
Line lamp
I.D.F.
Answering Jack
Line Lamp
i
D
Line Pilot Lamp
n
g
Morse Pony Relay
Buzzer
k
o
a
c
2
Line Relay
d
1
m
w
C
Sw.
A
b
B
-
+
e
f
h
G
Am. Elec.

FIG. 2.—COMPLETE CONNECTIONS FOR ONE LINE CIRCUIT.

The line pilot lamp is a 3-c.p. lamp, there being one for each operator's position, and it is placed above all the jacks so that the chief operator or monitor can easily see it. The pilot lamp is connected in series with the common battery, a Morse pony relay, and a contact, *1*, controlled by the line relay. Whenever the line relay is energized the pilot lamp lights up, and when the call is answered the line relay is released, thereby allowing the pilot lamp to go out. Thus, the pilot lamp should remain lighted for only a moment or so each time a call is received. Moreover, if it should remain lighted for an unusual length of time the chief operator can see that a line is being neglected, or is in trouble; in either case it is her business to make an investigation immediately.

It will be noticed that the Morse pony relay controls a circuit containing a buzzer, in series with which is a simple two-point switch, *Sw*. The buzzer is for use when but few operators are on duty, as at night. At such times the two-point switches are closed, so that the buzzer will sound whenever the pilot lamp lights. Thus, the operator, who may be at some remote section of the board where the pilot lamp cannot be readily seen, hears the buzzer and proceeds to look for the section where the pilot and line lamps are lighted and a connection is desired. By this means one operator can attend to a considerable number of sections when comparatively few calls are coming in.

The relays in Fig. 2 are not drawn to scale, but the levers and contact springs are enlarged and spread apart very much to more clearly show how they operate. Moreover, the line pilot lamp is usually located above the line lamps and all the jacks, as previously stated. At the section where the answering jacks are located, the corresponding multiple jacks are omitted. It is not necessary to repeat the answering jacks among the multiple jacks at each section, although it facilitates the operators' work, and is done in the switchboards of the American Bell Telephone Company. The latter company, or the Western Electric Company, more likely, owns a patent on this arrangement, and it is said not to have been used in the system here described for that reason.

When the line relay is energized, the armature, *w*, is attracted, thereby lifting the springs, *d* and *c*, so that they touch the contacts, *1* and *2*, respectively; and when the line-cut-off relay attracts its armature, *y*, the springs, *z* and *x*, leave the contacts, *3* and *4*, and touch the contacts, *u* and *v*, respectively. Contacts *2* and *1* form terminals for the line lamp and line pilot lamp, respectively. The line wires pass through the main distributing frame, *M. D. F.*, the contacts of the line-cut-off relay, and the coil of the line relay, to the common battery, *B*. The positive terminal of the battery is grounded at *G* for the busy test. The circuits are fused at *b* before going to the negative pole of the battery. *A* is a one-point distributing bar; *a n* is a wire common for one strip of relays, branching at *n* to the various relays in that strip.

When the line relay is cut out by the line-cut-off relay, the line circuit passes through the contact springs, *u* and *v*, to the intermediate distributing frame, *I. D. F.* From the first side of the intermediate distributing frame, branches go to the tip and sleeve springs of all the multiple jacks belonging to that particular line. All the tip springs are in multiple and all the sleeve springs are in multiple; hence, a poor contact at one jack, due to dirt or any other cause, affects only the one jack where it occurs, and not the entire circuit, as it would do in a so-called series-jack multiple board.

In addition to the two line wires, one wire running to the line lamp (from contact *2*) is also brought to the intermediate distributing frame. By jumper wires, these three wires are carried across the frame to the terminals connecting to a certain jack, and the corresponding line lamp at one section. The intermediate distributing frame is almost a necessity in a large exchange, for it facilitates the distribution of the line circuits that are used a great deal among the various operators. At any time it is an easy matter to relieve overworked operators by transferring some of their busy circuits to operators who have less work, without changing the subscriber's number.

For instance, suppose it is desired to change the answering jack and line lamp of subscriber No. 96 from section 1 to section 6 because the operator at section 1 has too much to do, whereas the operator at section 6 can easily attend to another line. At the intermediate distributing frame the jumper wires of line No. 96 would be disconnected from the terminals connecting to the answering jack and line lamp at section No. 1, and instead these jumpers would be connected to terminals connecting to a spare answering jack and line lamp at section 6. The subscriber's multiple jacks would remain the same as before, so that there would be no necessity to change his number. To be sure, he would have a differently numbered answering jack, but it would be necessary only to change the number of the one answering jack and corresponding line lamp.

Where the answering jacks are repeated among the multiple jacks at the same section, as on Bell switchboards, it is not even necessary to renumber the answering jack, because the answering operator does not need to know the real number of the line whose call she is answering. All she has to do is to plug in the jack that corresponds in number with the line lamp, the answering jack and corresponding line lamp always having the same number on any switchboard. But in the board here described, if a subscriber whose answering jack is at one section calls for another subscriber whose answering jack is at the same section, then in order to complete the connection the called-for answering jack must have its correct line number, since there is no jack in multiple with the answering jack among the regular multiple jacks. On a Bell switchboard, there would be such a jack. The advantage of the arrangement used by the Bell companies should now be apparent. Its real practical advantage would increase with the number of line circuits.

The wire *e-a-o* is common to all springs *d* on all the line relays; *m-D* is common to all the line lamps in one strip. All the strips of line relays for one operator's position connect to the one wire at *D*. Since there is one Morse pony relay at each operator's position, and all the Morse pony relays control the one buzzer, the line *b-k* is common for all positions, and the contact points of all the Morse relays come together at *6*. Since the wire *e-f* is common to all positions, and there is a switch, *Sw*, at each position, it is a simple matter to have the buzzer connected to any or all positions.

AMERICAN METER PRACTICE.

BY LYMAN C. REED.

RELATION BETWEEN METER LOSSES AND INCOME.

In the general consideration of the various engineering problems of central station management, the meter is generally relegated to somewhere near the tenth place in matter of importance. Its use is well recognized, but the necessities of its maintenance and operation are generally neglected, until to-day it is the least understood of all branches of electrical engineering, even by those who are acknowledged authorities.

It is easy to build a meter having a commercial efficiency of from 98 per cent to 99 per cent on half and full loads, and at first glance this appears to be a very creditable performance, but the question is what will this same meter do commercially on from 2 to 10 per cent of its load? The average load on the meters of a central station lies, as a rule, under 10 per cent of their capacity; this fact emphasizes the extreme importance of having the meters register correctly on this load.

In taking up the discussion of the losses in the meters and their relations to income, it is necessary to outline in a general way the main factors of cost of generation and sale of current from a central station. The three main factors which must be present to secure the successful operation of a central station are: First, never failing integrity of service; second, a market for the current; third, proper registration of current sold. The first and second of these factors will be assumed to exist; they lie outside of the scope of this discussion and may be considered in the same class as the prime requisites of any commercial undertaking. On the purely operative side of the business, the management of the meter department easily stands first in its effect on the economy of the selling of current from central stations.

The cost of current to the central stations is determined by its operating expenses and fixed charges per unit of current generated. The fixed charges, after the investment is made, remain a fairly constant factor per unit of current generated, hence economy in operating expenses becomes the chief aim of the central station manager. It is necessary, for the sake of brevity, that we accept the conditions which we find prevalent in the actual cost of generation of current, without going into details. In this connection a brief summary of what is considered fairly representative cost in the art as it is to-day will be given.

The cost of generating a kilowatt-hour varies with the locality, cost of fuel, etc., but the range may be taken as from one-half to one and a half cents per kilowatt-hour at the switchboard. It is assumed that the plant is of modern construction, with compound or triple expansion engines as prime movers, having the usual auxiliaries pertaining to the best modern practice. Under such conditions one-half cent per kilowatt-hour would represent extremely favorable conditions, and one and one-half cents per kilowatt-hour good conditions, so that an average of one cent per kilowatt-hour may be taken as a basis of cost for the purpose of showing the relative cost of generation to income in contrast with the meter loss to income. In assuming one cent per kilowatt-hour as cost at the switchboard, it would be necessary to assign values to the various items which go to make up this total, so as to show what percentage the different items of cost bear to income.

Fuel consumption will be taken at three pounds per kilowatt-hour, and the price at $2 per ton, making the cost for fuel per kilowatt-hour 0.33 cent, leaving 0.67 cent to cover labor, maintenance, oil, etc. Assume an average daily output of 30,000 kilowatt-hours, and the usual line and meter loss of 25 per cent between the bus-bars and the aggregate amount registered by the consumers' meters. Assume also an average net price of 10 cents per kilowatt-hour for service as registered by the consumers' meters. Then the net receipts for energy measured at the switchboard would be 7½ cents per kilowatt-hour.

From the foregoing, the ratio between cost of coal and the net amount received per kilowatt-hour is roughly 1 to 22.7, or the cost of coal is only 4.4 per cent of the net income. Any loss or saving in the coal pile of from 10 to 20 per cent only affects the net income by a fraction of 1 per cent. Under the conditions assumed, the total cost of generation is 13 1/3 per cent of the net income, and even if the most rigid economies permissible to good practice were instituted, and the cost per kilowatt-hour reduced thereby to ¾ cent, a saving of only 3 1/3 per cent of the net income would be the result.

It is not the writer's intention to belittle any practice which reduces the cost of generation, but merely to draw a comparison between these losses and a loss which is in excess of their total, namely, the loss in the meters themselves. It may be safely stated that in a carefully-operated central station the net saving in generation which could be effected by the most rigid economies, will not exceed 3 per cent to 4 per cent of the net income. The effectiveness of the introduction of any saving in the cost of generation is limited in extent—that is, it can never approach closely to its limit in the present illustration of the 13 1/3 per cent of the net income.

In taking the total loss in lines and meters at 25 per cent, the average condition of the large central stations in America is represented. The usual loss attributable to meters is 15 per cent, and 10 per cent is the usual line loss. The loss in transmission from the switchboard to the consumer will be made as large or small as one pleases, according to the amount of copper used for distributing the current. A 10 per cent loss in the lines means that the generating equipment must be 10 per cent larger than that necessary to meet the actual demands at the consumers' premises.

Any reduction in line loss means larger copper investment, and any increase in line loss means larger generating capacity, so that there is established somewhere an economical balance which varies for different conditions, but may be roughly taken as corresponding to a 10 per cent loss in the distributing system. This line loss of 10 per cent in the example given above means that only 27,000 kilowatt-hours are delivered to the consumer, of which only 22,500 kilowatt-hours are registered after the 15 per cent meter loss is deducted. The line loss may be considered as being included in the cost of generation, since if the line loss is reduced a reduced amount of current is generated at a reduced cost and *vice versa*. The meter loss, on the contrary, is in current actually delivered and used by the consumer but not paid for by him. The loss is of such a nature as to affect the dividend directly by its amount. The general expenses of the plant and system are not altered whether it is saved or lost. It seems incredible that a loss of this magnitude should be tolerated, a loss which, if saved, would offset the entire cost of generation.

The peculiar conditions prevalent in central station practice bring about a condition of affairs which is very trying to the correct registration of current. The meter capacity installed usually equals the load connected to the lines. The maximum output of a central station feeding a distributing system for light and power rarely exceeds 20 per cent of the load connected, and the minimum output falls as low as 2 to 3 per cent of the load connected or the meter capacity. Thus it is evident that the meters, as a whole, register on from 2 per cent to 20 per cent of their rated capacity, the mean load falling as low as from 6 per cent to 10 per cent of their capacity. When the problem is looked at broadly in this light it is not difficult to see why a meter having a high commercial efficiency on half and full loads fails to register properly on the average load that it is required to record.

As an example of the trying conditions under which meters work, take the case of a store having 100 16-c.p. lamps installed. During the day, from 7 a. m. until 4 p. m., assume that two lamps are burned; from 4 p. m. to 6 p. m., an average of 50 lights are used, and from 6 p. m. until 7 a. m. next morning, one light is left burning. If the current were correctly registered, the amounts for the different hours would be as follows:

7 a. m. to 4 p. m.,	9 hours at	2 cents..	$0.18
4 p. m. to 6 p. m.,	2 " "	50 cents..	1.00
6 p. m. to 7 a. m.,	13 " "	1 cent...	0.13
			$1.31

A meter of 100 lights capacity in commercial practice does not register 1 or 2 lights with any degree of accuracy, in all probability not running at all on one light. The loss in this instance per day on the small burning of $1.31 would be, say 25 cents, or 18 per cent of the amount registered. This case represents a prevalent condition. There are exceptions where the meter is always worked at a load under which it is practically correct; on the other hand, the conditions may be easily more adverse. At any rate, the average conditions are sufficiently adverse to cause a general loss of 15 per cent of the current delivered, and that, too, by meters which on loads of 20 per cent of their capacity are commercially accurate.

The solution of this problem would be one of the greatest benefits to central stations. The solution so far has not been embodied in any meter on the market, but there are various auxiliary means and devices for greatly improving and in many cases eliminating these losses. Any such auxiliary device increases the meter investment, and this may account for the slowness in adopting them, but their desirability is so imperative, pending the development of a perfect meter, that a description of several methods of improving the efficiency curve of a meter by their use will be given in a future article.

◆◆◆

Steam Leakages.—The matter of leakage of valves and pistons in steam engines is one of importance. In testing engines it is very often overlooked, and in the ordinary working of a large number of engines it is the cause of a great waste of steam. It is commonly believed that the indicator diagram is useful for the purpose of showing the condition of the engine with regard to leakage; but the manufacturers of indicators say that such a belief is erroneous, as the indicator was never intended for any such purpose Leakage of steam, except where excessive, has so little effect on the lines of the indicator diagram that it is scarcely possible to detect it. The only satisfactory way to determine whether or not an engine is steam tight, is to subject it to the full boiler pressure with the valves closed and the piston blocked in some way at some point away from the end of the stroke.

Lessons in Practical Electricity

MAGNETIC INDUCTION OF ELECTROMOTIVE FORCE.—PULL ON A CONDUCTOR IN A MAGNETIC FIELD.

If a wire be passed across a magnetic field transversely to the "direction" of the magnetic lines of force, the wire is said to "cut" the lines of force. Such action will induce an e.m.f. in the wire, the strength of which will be directly proportional to the number of lines of force across which the wire would "cut" within one second of time, if it were moved continuously for that length of time—in short, the *rate* of cutting lines of force. Cutting 100,000,000 lines per second will set up an e.m.f. of 1 volt; consequently, the e.m.f. set up in any wire moved across a magnetic field may be found by dividing the rate of cutting per second by 100,000,000 (usually written 10^8). The rate of cutting is equal to Flux ÷ Seconds, or $\frac{\Phi}{t}$, and dividing this by 10^8 gives

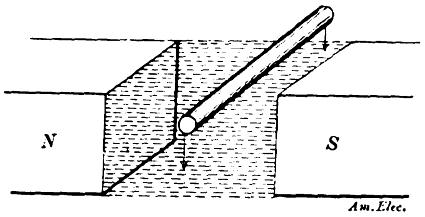


FIG. 1.—CUTTING LINES OF FORCE.

$$\frac{\Phi}{10^8\,t} = E \ldots\ldots\ldots\ldots (1)$$

For example, referring to Fig. 1, where *N* and *S* represent the poles of a magnet, if there were 100,000,000 lines of force in the space between the poles and the wire were carried downward at such a speed that it cut across the whole field in exactly one second, an e.m.f. of one volt would be set up in the wire. And if it cut the whole field in half a second, an e.m.f. of two volts would be set up, because the *rate* of cutting would be twice as high as in the first case, although the same total number of lines would be cut. It is scarcely necessary to say that the e.m.f. would exist only while the lines were being cut by the wire.

If the wire be extended and formed into a loop, so that a closed circuit may be obtained, as in Fig. 2, the ends being secured by a clamp, *e*, any motion of the rectangular loop that causes one side of it to "cut" the lines of force, will cause a flow of current in the wire, due to the e.m.f. induced in it. Thus, if the loop be drawn bodily downward, as indicated by the arrowhead, *a*, the upper horizontal stretch of wire, *w*, will cut across the field, and current will flow in the direction indicated by the arrow, *f*, in the wire, *w*; if the loop be pulled sidewise in either direction, as indicated by the arrowheads, *b* and *d*, current will flow also in the direction of the arrow, *f*. And if the loop be pulled upward, as shown by the arrowhead, *c*, the "spliced" side of the loop will cut the magnetic field and the induced e.m.f. will be in the same direction as before, sending the current as shown by the arrow, *f*. In short, it is impossible to remove the loop from between the magnet poles, maintaining it in a perpendicular plane, without causing a current to flow in the direction indicated by the arrow, *f*, while the wire is cutting the flux.

If the polarity of the magnet were reversed, making the north pole south and the south pole north, the direction of the current induced in the loop by pulling the latter across the field would be opposite to the arrow, *f*.

In drawing one side of a loop across a magnetic field, as described, work is done, as is made evident by the flow of current in the wire. (Drawing the straight wire across, as in Fig. 1, results in no work, although an e.m.f. is induced in the wire.) The power developed in the loop by moving one side of it across the field will be given by the formula

$$\frac{\Phi \times I}{10^8 \times t} = \text{watts,}$$

in which Φ is the number of lines of force in the field; *I* is the current in the wire, and *t*, the time in seconds required for the loop to cut the whole field. The e.m.f. induced in the wire, as before stated, is equal to Φ ÷ 100,000,000 *t*. The current, *I*, in the wire will be equal to *E* ÷ *R*, and as watts = volts × amperes, Φ ÷ 100,000,000 multiplied by *I* = watts, as stated in the formula above. In consequence of doing the work indicated by the formula there will be an opposing pull or drag on the loop when it is withdrawn from the magnetic field, and it is for deducing the amount of this pull that the formula last given is chiefly useful.

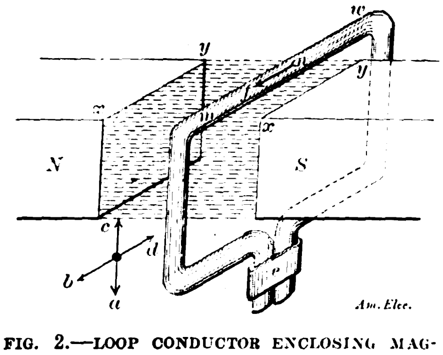


FIG. 2.—LOOP CONDUCTOR ENCLOSING MAGNETIC FIELD.

Electrical power in watts corresponds to mechanical power in foot-pounds per second, as explained in an earlier Lesson; one watt is equal to 0.7373 foot-pound per second. Therefore,

$$\frac{0.7373 \times \Phi \times I}{10^8 \times t} = \text{power in foot-pounds}$$

per second, and consequently,

$$\frac{0.7373 \times \Phi \times I}{10^8} = \text{work in foot-pounds.}$$

Now, the foot-pounds of work done in any case are equal to the pounds of force required to do the work, multiplied by the distance (in feet) through which that force is exerted. Representing the distance in feet by *D* and the force in pounds by *F*, *D* × *F* = foot-pounds. So that it is only necessary to divide the work done by the current in the loop by the distance the loop is moved, in order to ascertain the pounds of pull required to drag one side of the loop across the magnetic field. Thus,

$$\frac{.7373 \times \Phi \times I}{10^8 \times D} = \text{pull in pounds.}$$

In dragging one side of the loop across the field, only that one stretch of wire cuts the lines of force; this is termed the "active" part of the wire. Thus, in Fig. 2, if the loop be pulled downward (as indicated by the arrowhead *a*), that part of the wire between *m* and *n* would be the "active" part, *i. e.*, the whole e.m.f. would be induced in that one stretch of wire; the remainder of the loop would serve merely as a conductor to close the circuit and permit current to flow. The distance between *m* and *n* is called the "active length" of the wire, and is equivalent to the width of the magnet poles, from *x* to *y* (ignoring leakage for the present). If this length be called *l*, it will be clear that the transverse area of the field in square inches will be equal to 12 *D* × *l*; *D* still being the distance in feet that the wire *w* moves in order to cut the whole field. Also, 12 *D* × *l* × *B* will be equal to Φ; *B* representing the magnetic density of the field. Therefore, instead of the formula last given for pull in pounds, one may substitute:

$$\frac{0.7373\ I}{10^8\ D} \times 12\ D\ l\ B,$$

which reduces to

$$\frac{B\ l\ I}{11{,}302{,}363} = \text{pull in pounds} \ldots (2)$$

It is sufficiently near to exactness in ordinary practice to make the denominator 11,300,000, as this involves an error of only one-fiftieth of 1 per cent, which is considerably less than the error in the instruments with which measurements are usually taken. Recapitulating: *B* represents the magnetic density in lines per square inch of the field flux; *l*, the active length of the wire in inches, and *I*, the current in it. And the result is the pull in pounds required to draw a wire across a magnetic field when its ends are connected *outside the field* by a conductor of such resistance that the current *I* is permitted to flow.

This formula, (2), shows that the speed with which the wire is drawn across the field does not affect the pull, so long as the current strength is not affected. In the elementary case used here for illustration the speed would affect the current strength, because it determines the e.m.f. and that determines the current, but in practical working the current is usually controlled by outside influences, such as adjustable resistances, by means of which the desired strength may be obtained, irrespective of the speed of the wire across the field. For such a case as that of Fig. 2, where the speed affects the current, the pull would be given by the formula:

$$\frac{B^2 l^2 v}{11,302,363\, R\, 10^8} = \text{pull in pounds.} \quad (3)$$

Here v represents the velocity of the wire across the magnetic field in inches per second, and R is the resistance of the wire loop.

Letters on Practical Subjects

Mr. De Witt's Annunciator Wiring Problem.

To the Editor, American Electrician:—

The accompanying diagram is submitted as a solution of Mr. De Witt's annunciator problem published in the February number of the AMERICAN ELECTRICIAN. You will notice in the diagram that only six wires are used between the distant rooms or offices. The battery, *a*, is used exclusively for operating the annunciator, and the battery, *b*, is used exclusively for ringing the bells, *B1*, *B2*, *B3* and *B4*. The home pushes, 1, 2, 3 and 4, are numbered to correspond with the bells which they ring. While the main battery wires are entirely separate, the individual wires between each room or office and the annunciator room serve both for the annunciator and the bell circuits. This arrangement gives a saving of about 25 per cent of copper over the single-circuit system.

L. R. MCDONALD.

Montreal, Canada.

[This solution was also sent in by Jas. B. Dillon, Louisville, Ky., and H. I. Lurye, New York.—ED.]

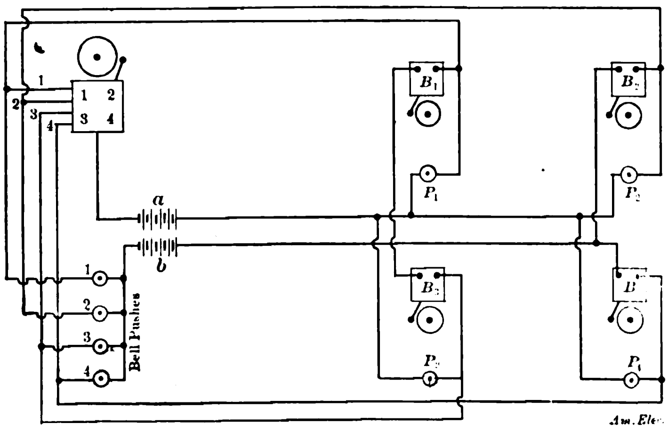


FIG. 1.—MR. M'DONALD'S SOLUTION.

To the Editor, American Electrician:—

Enclosed please find a solution of Mr. S. C. De Witt's problem in bell wiring which appeared in your February number. By using two-way push-buttons, *P1*, *P2*, *P3* and *P4*, only six wires are required between the annunciator room and group of distant rooms. The lower contacts of all the push buttons are connected to the common-return wire of the battery, *a*, which operates the annunciator; the upper contacts are connected to the individual bells through the common return of the battery *b*, which operates the bells. It is obvious that when one of the push buttons, say *P1*, is depressed to ring the annunciator bell, the circuit through the local bell, *B1*, will be open, so that this bell cannot be rung from the main office. This is not a disadvantage, however, for the reason that it is not necessary to signal simultaneously.

A single battery could be used by making the system an ordinary hotel return-call system, and using double-point push-buttons at the main office as well as in the individual rooms. The individual lines from the push-buttons in the rooms to the main office push-buttons would connect to the heel of each button. The upper contact of each main-office push-button would go to the proper annunciator binding post, and the lower contacts to the common battery connection. This arrangement would also require six wires unless a ground return were used, in which case five wires would do for either system.

WM. A. LOVELAND.

Wilmington, Del.

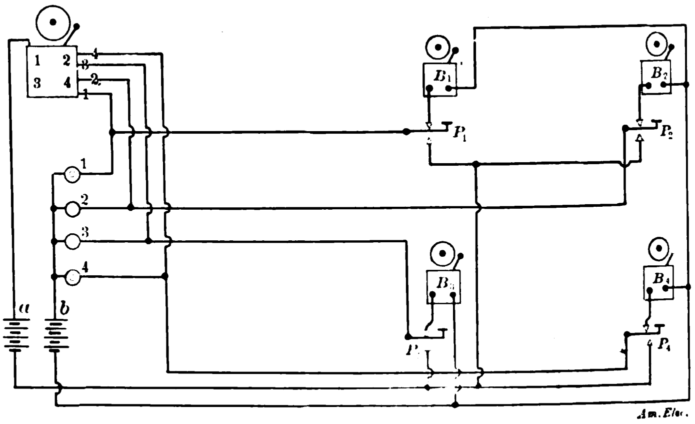


FIG. 2.—MR. LOVELAND'S SOLUTION.

To the Editor, American Electrician:—

The accompanying diagram is submitted as a solution to Mr. De Witt's return-call problem in the February number. The push-buttons are all of the double-contact or two-way type, as indicated in the diagram. It is evident that depressing any one of the main-office push-buttons will complete a circuit through the push-button spring, upper contact and local bell in the corresponding distant room, back through the battery, *b*. It is also evident that for any number of rooms there will be required only two wires more than the number of rooms, these being the two common-return wires to the batteries, *a* and *b*.

OTTO SCHRAMEK.

New York City.

[This solution was also sent in by C. H. Hodgkins, Providence, R. I., and W. A. Pulliam, Alleghany, Pa. It was also suggested by Wm. A. Loveland, Wilmington, Del., in the same letter containing the solution shown by Fig. 2.—ED.]

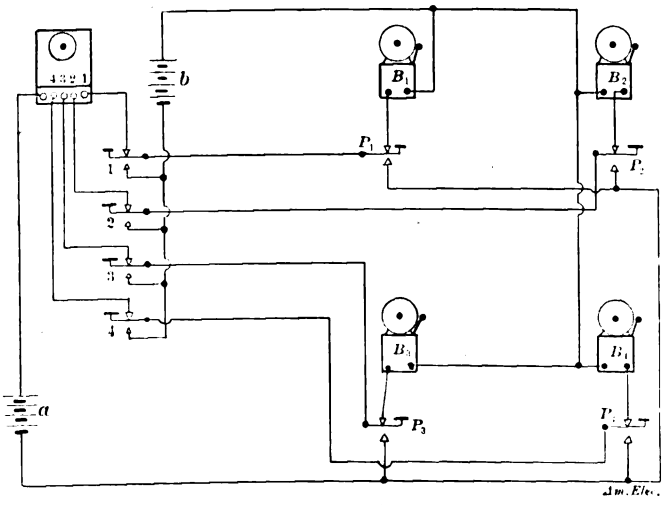


FIG. 3.—MR. SCHRAMEK'S SOLUTION.

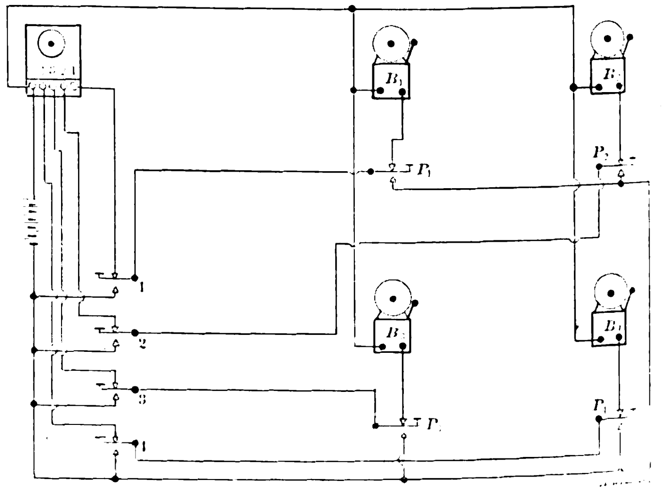


FIG. 4.—MR. FISK'S SOLUTION.

To the Editor, American Electrician:—

The accompanying hasty sketch shows a wiring plan which will fulfill the conditions imposed in Mr. De Witt's problem in annunciator wiring that was published in your February number. The push-buttons are the ordinary return-call or double-contact form, both in the rooms and in the main office. The duplicate wiring specified has not been shown, as such a feature would not be included in any ordinary work; neither have I shown two batteries, as one is sufficient for the operation of the system. If it should be considered advisable to have a duplicate battery as a reserve, this can easily be accomplished without any special wiring.

Pittsfield, Mass. EDWIN R. FISK.

[This solution was also submitted by Henry M. Webb, Rochester, N. Y.—ED.]

To the Editor, American Electrician:—

I enclose herewith a solution of Mr. De Witt's annunciator problem, which will be clear to anyone accustomed to installing annunciator systems. The main battery is divided into two sections, *a* and *b*, the one for operating the annunciator and the other for operating the bells. The main-office push-buttons, 1, 2, 3 and 4, ring the bells in the distant rooms, each push-button ringing the bell numbered correspondingly. The push-buttons, *P1, P2, P3* and *P4*, in the rooms, close the respective circuits through the annunciator drops, in the usual manner.

New York City. F. SCHUMACHER.

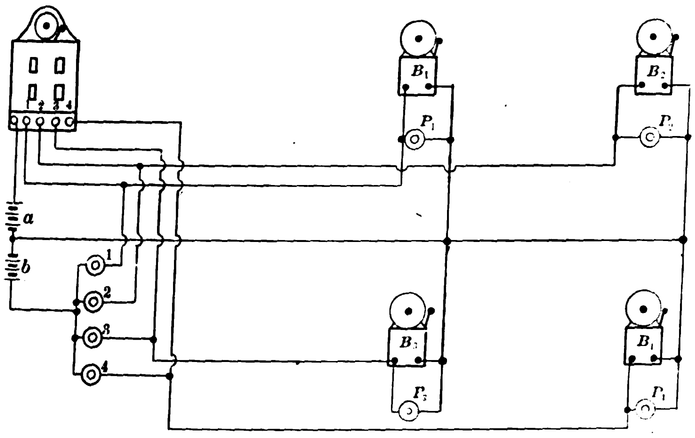
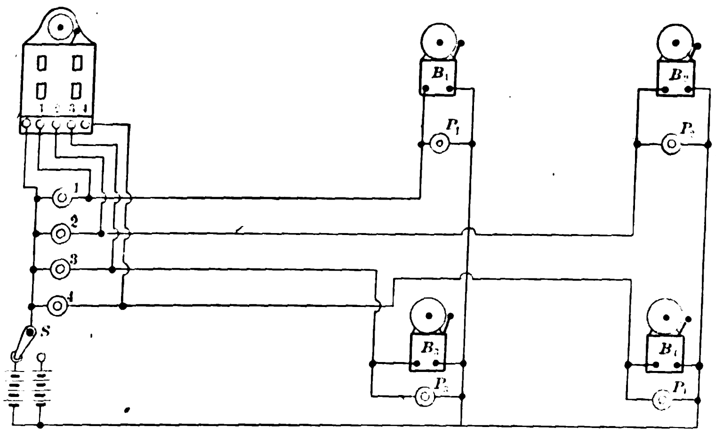


FIG. 5.—MR. SCHUMACHER'S SOLUTION.

To the Editor, American Electrician:—

The accompanying diagram shows a method of wiring which fulfills all of the requirements in Mr. De Witt's problem which has appeared in your February issue. It will be evident, upon tracing the connections, that the main-office push-button, 1, closes the circuit through the battery and the bell, *B1*, and that the other push-buttons close the circuits through the other bells, respectively. The push-buttons, *P1, P2*, etc., close the circuit through the battery, annunciator bell and proper annunciator drops. Only a single common-return wire is used, and the individual wires between the main office and the rooms serve both the bells and the annunciator. Two batteries are shown in connection with a two-way single-pole switch, *S*, by means of which either battery can be thrown in circuit; when one battery is exhausted, the other one is thrown in. LOUIS KNOP.

Detroit, Mich.



Am. Elec.

FIG. 6.—MR. KNOP'S SOLUTION.

[The solution submitted by Mr. McDonald, and shown by Fig. 1, corresponds precisely with the original solution of the author, Mr. De Witt. The solution of Fig. 2 departs from this only in the use of double-contact push-buttons in the rooms. As pointed out by Mr. Loveland, the depression of a push-button in one of the rooms opens the bell circuit at that point, so that if it should happen accidentally that the push-button, *P1*, for example, were depressed at the same instant that the main-office push-button, 1, were depressed, the signal from the main office would not be transmitted. The solution shown by Fig. 3 is a still further elaboration of the original solution, two-point push-buttons being provided in both the office and the rooms. The general theory of the wiring, however, is the same. This solution is open to the objection that if a push-button in the main office were depressed at the same instant that the corresponding button in a distant room were depressed, neither one of the signals would be transmitted, as both the bell circuit and the annunciator circuit would be open. The method of connection shown in Fig. 4 is remarkably similar to that shown in Fig. 3, the only difference being that a single battery is employed instead of two separate batteries, the return wire from the bells being connected to the opposite end of the battery from that to which the common return to the push-buttons is connected. This system is also open to the objection that the simultaneous depression of two push-buttons of the same number would result in no signal being transmitted either way. Mr. De Witt's requirement as to the use of two batteries could obviously be met in this case by providing a reserve battery, to be thrown in in the manner indicated in Mr. Knop's solution, Fig. 6.

Fig. 5 is a somewhat ingenious method of wiring, in which the number of wires between the annunciator station and the group of distant rooms is reduced to 5 instead of 6. This method, however, is open to the serious objection that the annunciator circuits are permanently closed through the individual bells in the various rooms; consequently, either the battery or the bells would have to be so nicely adjusted that the latter would not respond when in series with the annunciator drops and bells. It is doubtful if this result could be obtained in practice. Another objection is that the battery, *a*, is constantly on closed circuit through the annunciator and the distant bells. Still a third objection is that the simultaneous depression of an office push-button and a room push-button of the same number will not only result in failure to transmit a signal in either direction, but will put a dead short-circuit on the battery, *b*.

Mr. Knop's solution, Fig. 6, is wired on practically the same principle as Mr. Schumacher's system, just referred to, the only differences being that both the annunciator and the bells are rung from the same battery, and that an idle battery is kept in reserve, instead of having two batteries actively connected. In this case, as in Mr. Schumacher's, the battery is on closed circuit through the annunciator and bells, and impractically fine adjustment would be required to prevent continuous ringing; also, the simultaneous depression of two push-buttons having the same number will short-circuit the battery.

In all of the diagrams we have taken the liberty of changing the wiring so as to open it up more and make the connections clearer. It will be obvious to any practical wireman that all of the wires between the annunciator room and the group of four rooms would be run together through the center of the diagram, and most of our correspondents showed the wires thus disposed. The main feature of the problem was to keep down the number of wires between the annunciator station and the four rooms or offices. A large number of other solutions have been received, but these are not published, for the reason that the number of wires between the annunciator station and the distant rooms exceeds six, which was the number established as the criterion by the author's solution. —EDITOR.]

A Simple Hotel Telephone System.

To the Editor, American Electrician:—

The accompanying diagram represents a simple telephone system adapted for operation in connection with single-call hotel annunciators, which has been devised by the writer and is submitted in the hope that it may be of interest to your readers. The system is a central-energy system, but in order to simplify the apparatus and circuits, separate batteries are used for ringing and talking. The talking battery has a common-return wire extending to all of the stations, and the gas or water pipe system of the building is used as a return for the ringing battery. The diagram represents circuits for six stations or rooms, the instruments for these being indicated at the right-hand side of the engraving. In all cases *T* indicates a transmitter and *R* a receiver.

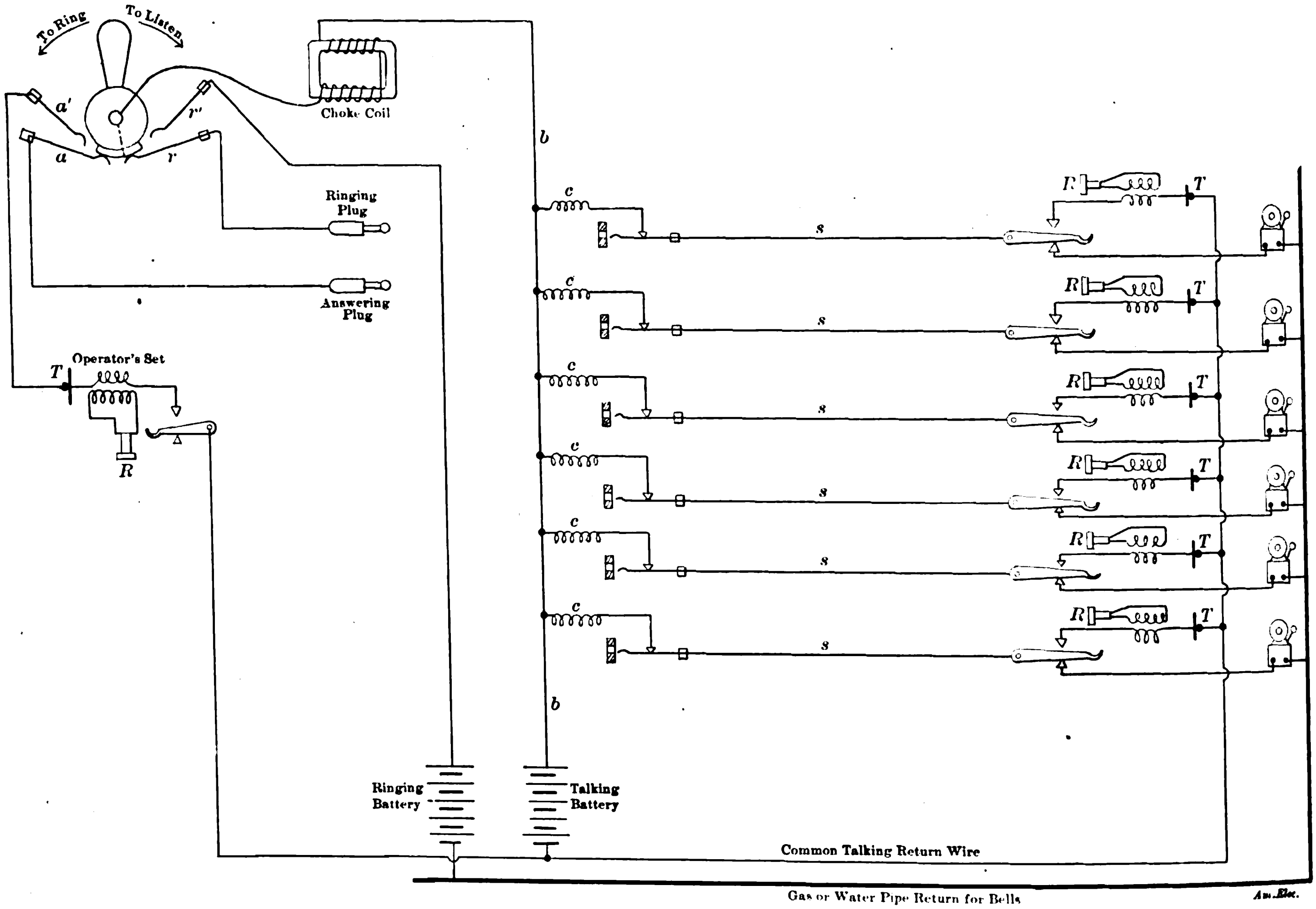


FIG. 1.—DIAGRAM OF CONNECTIONS FOR SIMPLE HOTEL TELEPHONE SYSTEM.

The switchboard arrangement is extremely simple, consisting of a single connection plug at each end of each cord circuit, and a one-spring jack for each station. The diagram shows the connections for a single-cord circuit and the central operator's set. A combined listening and ringing key of the rocking or oscillating type, similar to those in general use, is employed. The key is thrown to the left, as stated in the engraving, for ringing, and to the right for listening in. Each circuit, of course, has a ringing and listening key and choke coil, one terminal of every choke coil being connected to the talking battery wire, *b*. The operation is as follows:

In order to call up a room, the central operator inserts the ringing plug in the proper jack, pushing the jack spring away from its contact and thereby disconnecting the service wire, *s*, from the coil *c*, which is connected to the talking battery wire, and at the same time connecting the service wire, *s*, to the ringing spring, *r*, on the ringing and listening key. Throwing the key to the left then connects the wire, *s*, of the desired station to the ringing battery through the springs, *r* and r^1, and rings the bell in the distant room. Then reversing the position of the operator's key and substituting the answering plug for the ringing plug in the jack puts the central telephone set in connection with the called station. Removal of the receiver at that station allows the hook-switch to change the connection from the bell to the transmitter circuit, as usual, and conversation is then carried on by means of the common talking battery. When two stations are talking to each other, they are connected in the usual fashion by the two plugs of a cord circuit and the springs, *r* and *a*, on the operator's key; the metal segment on the key, which forms a bridge between the two springs, is connected to one terminal of the choke coil. This is necessary in order to permit the use of a common talking battery.

The system is open to the disadvantage that the central operator after calling up a station cannot listen in except by reversing the ringing key and changing the plugs in the jack, but as telephone service in a hotel of ordinary size is not heavy, this is not serious; no difficulty has been experienced on this account with an experimental installation recently put in by the writer. A convenient feature lies in the fact that by throwing any ringing and listening key to the left without inserting any plugs in the jacks, the bells of every room will be rung simultaneously, as this connects the ringing battery through the choke coil to the wire, *b b*, which is in connection with all of the individual service wires through the coils, *c*, and the jack springs. This feature permits a fire alarm signal to be transmitted to all of the rooms without any manipulation other than the simple throwing over of one ringing key.

PERCY M. BROWN.

Toronto, Canada.

The Neenan Elevator System.

To the Editor, American Electrician:—

In the description of my elevator system which appeared in your March number, one or two essential features were not mentioned. A very important feature consists in an arrangement whereby the counterweight strikes a lever when the car reaches the top of the shaft, depresses this lever and thereby relieves the tension device which normally maintains the endless hoisting cables taut

The relief of the tension on the cables enables them to slip freely around the hoisting drums and thus prevents the elevator car from being drawn against the timbers at the top of the shaft, and the possible breakage of the cables, should the motor, by reason of accident to the controlling device, continue to run after the car reaches the top landing. The counterweight, of course, does not operate the tension release until after the car has passed the top landing by a predetermined margin. Also, the statement that "the weight of the upper hoisting drum largely compensates the upward pull of the hoisting cables" is incomplete. The total weight of *both* drums is opposed to the upward pull of the cables and reduces the pull on the stationary central bearing to that extent.

M. E. Neenan.

New York, March 10, 1902.

◆

Emergency Lamp Control for Small Number of Outlets.

To the Editor, American Electrician:—

In your remarks relating to the solution of my problem in lamp control that was submitted by Mr. A. B. Smith and others, and published in the January number, you expressed the opinion that special permission might be obtained from the Underwriters to install this arrangement. This, however, is contrary to my experience with the local board here. I enclose herewith a diagram which complies with the Underwriters' rules, and which can be used when only a few outlets are to be controlled, but is impracticable where a large number must be wired up, on account of the size of switch necessary. To install such a system for 50 or 60 outlets, for example, would be out of the question, as each outlet would require a separate contact on the emergency switch.

Chas. J. Sutter.

St. Louis, Mo.

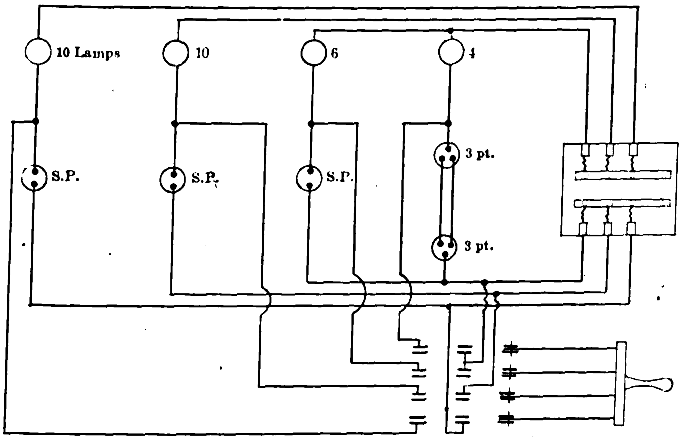


FIG. 1.—EMERGENCY LAMP CONTROL.

◆

Booster Transformer Connections.

To the Editor, American Electrician:—

In regard to connecting booster transformers, as suggested by Mr. Ryder in this department of the February number, I wish to point out a weakness in that method of connection which might prove disastrous to the transformer. It is well known that the magnetizing current of a transformer at no load is a very small fraction of the full-load current. It follows, therefore, that any considerable increase in this current will result in a corresponding increase in the voltage induced in the coils of the transformer, if the magnetic reluctance of the transformer core is assumed to be constant at different flux densities. When the booster transformer is connected according to the diagram in the February number, as long as the primary coil is connected to the circuit the conditions are normal. If, however, the primary is open, the current through the main line will magnetize the core to a tremendously greater extent than the normal magnetizing current and induce an e.m.f. in the open primary winding which will surely puncture the insulation of the coils. The primary circuit should never be opened while the main current is passing through the secondary coil.

P. C. Butte.

San Francisco, Cal.

[This disadvantage was recognized by Mr. Ryder, but he requested that reference to it be omitted, in order to ascertain whether or not any of our readers would detect it.—Editor.]

Electrical Catechism

670A.—What are the other laws of electrolytic action.

(14.) Ohm's law holds good for electrolytic conduction. Thus, the resistance of a cell varies directly with the distance between the electrodes and inversely with their size. The total e.m.f. necessary for deposition consists of two parts, one equal to the e.m.f. of polarization and the other equal to the product of current by ohmic resistance of the cell.

(15.) Secondary reactions may result in (a) the ions decomposing, as SO_4 may decompose into SO_3 and O; (b) the ions reacting on the electrodes, as in the case of storage batteries; (c) the ions being liberated in an abnormal state, as when oxygen is set free in the state of ozone.

(16.) An electric current sometimes seems to act as a directing force to set in operation chemical forces previously latent. Thus, the damage to underground pipes seems in some cases to be due only secondarily to the electric currents from the street railways which put into action chemical forces latent in the soil.

671. What are the more common electro-chemical processes?

The processes known the longest are those of electrotyping, electroplating and the electrolytic refining of metals. In recent years much attention has been given to processes in which heavy currents cause high temperatures, as in electric furnaces, and in which chemical reactions take place as results of the temperature, or of the current alone (in which case the heat simply changes the substances from non-conductors to conductors), or of both the current and the heat. Electric furnaces depending on heat without electrolysis have been discussed in this department of the American Electrician for July and August, 1901. Much attention has been given also to the electrolytic manufacture of alkali, chlorine and their products, and of organic compounds and chemicals.

672. What are the differences between electrotyping, electroplating and the electrolytic refining of metals?

The three processes are similar in general theory, although many differences exist in the details of practical operation. Electrotyping consists in making copies of surfaces by the help of molds. Electroplating is the process of electrically depositing a layer of metal upon any desired surface, generally that of some other metal. In the electrolytic refining of metals, impure metal is dissolved from the anode and pure metal is electroplated on the cathode.

673. Are these processes new?

They are among the oldest of the applications of electric current. In 1800, Cruickshank found that copper could be separated from its solutions by means of the electric current. Becquerel made many experiments on the electrochemical treatment of ores containing silver, copper and lead, between 1835 and 1840. Jacobi reported, in 1838, that exact copies of irregular surfaces could be made by depositing on them electrically a metal shell. It was only after 1867, when the dynamo began to be developed, that the electric refining of metals reached a commercial stage. The reverse of electroplating, the process of electric pickling, or cleaning metallic surfaces, has been used for many years in preparing surfaces for plating, and in the last few years has been extensively developed.

674. Explain the process of electrotyping.

The process consists of making a mold or impression of the surface to be copied, preparing the mold so that its surface is a conductor of electricity, and then electrically depositing upon it a coating of the desired metal. In some cases the electrically-deposited shell is then removed from the mold, and is reenforced by the addition of a backing of some cheaper and more easily fusible metal.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

How can the carrying capacity of a fuse wire be ascertained? D. N.

Only by actual experiment.

Where can I obtain directions for making a direct current voltmeter and ammeter? F. C.

From our book entitled "Electrical Designs"; price, $2.

How is a six-room return-call annunciator wired? F. J. E. S.

Any of the methods described in the Letters Department of the present issue may be used.

What constitutes an asynchronous motor? A. E. E.

An alternating-current motor which does not run in synchronism with the alternations of the circuit. An induction motor is an asynchronous machine.

How can a telephone receiver be made which will amplify the sound? L. F. O.

Such a receiver would probably require more power for its operation than is delivered to the line through the medium of the transmitter, and multiplication of power is an impossibility.

Is a shunt motor advisable for driving a winch where reversing is necessary? G. A. M.

A shunt motor may be used, of course, for almost any class of service, but for this kind of work either a plain series motor or one with a compound winding would be preferable.

What is meant by the "terminal" pressure of a steam engine? (2) What is meant by "receiver" pressure? S. D. I.

The pressure of the steam in the cylinder at the instant that the exhaust valve is opened. (2) The pressure of the steam in the receiver of a compound or triple-expansion engine.

Would it not improve the operation of an induction coil to use a secondary core consisting of a thin sheet-iron tube around the primary core? B. H. F.

No; this would form a closed secondary circuit for the primary winding and reduce the power of the secondary winding to a probably useless value.

In a three-phase delta-connected system are there three separate currents, or is it originally a single current divided into three parts? L. C. M.

Three distinct currents are generated in the armature winding, but these combine at the terminals of the winding so that in the line wires it is scarcely possible to ascribe identity to the currents.

What is the difference between inductance and self-induction? G. K.

Self-induction is a phenomenon and inductance is a property. A coil of wire has a certain inductance whether any current passes through it or not, but no self-induction can take place unless an intermittent or alternating current is passed through the coil.

Can the voltage of an 1100-volt alternator be doubled without rewinding it? W. H.

If the armature winding is divided into two groups of coils connected in parallel for 1100 volts, the machine can be made to give 2200 volts by connecting the winding in series. If it is already a simple series winding, the voltage cannot be doubled without rewinding the armature.

Should the series field winding of an electric elevator motor oppose the shunt field winding? C. P.

This depends on the system in use. In most cases the series field winding assists the shunt field winding; in some systems, however, the controller connections are such that the series winding assists the shunt winding while the motor is coming up to speed, but is reversed so as to oppose it after it reaches full speed. This is an unusual arrangement.

How can verdigris be removed from brass and copper? J. R.

If the metal is greasy, give it a preliminary washing with a solution of caustic potash in hot water. Then dip it in the acid bath specified below, wash it thoroughly in clean water and rub it dry in sawdust. The acid bath consists of one part of commercial sulphuric acid and two parts of commercial nitric acid mixed in an earthenware jar. The operation should be performed out of doors, as the fumes are poisonous.

Of what is the filament of an incandescent lamp made? (2) What is meant by flashing? R. C. E.

The base of the filament is cellulose, which is "squirted" into the proper form and carbonized; this then has carbon deposited on it uniformly, the process by which this is done being known as "flashing." This process consists of putting the cellulose filament in a vessel containing hydro-carbon gas and passing current through the filament until carbon is deposited on it from the gas to a sufficient extent to reduce its resistance to a predetermined value.

How can a compound dynamo be restored to its original condition after it has been "motored" and will not pick up? (2) Why is a syphon attached to a steam gauge? C. W. R.

Raise the brushes from the commutator and close the main switch of the machine, connecting it to bus-bars supplied by some other machine at the proper voltage. (2) In order that water may collect in the syphon and interpose between the steam and the working parts of the gauge, delivering the pressure of the steam to the mechanism without its being subjected to the high temperature of the steam.

What is the difference between "foot-pounds" and "pound-feet?" W. E. K.

The foot-pound is a measure of work, the amount of work done being ascertained by multiplying the force employed by the distance through which the force is exerted; the force being measured in pounds and the distance in feet. The term "pound-feet" is applied to torque or angular pull. The torque of a machine, such as a motor, in pound-feet may be found by attaching a lever a little over a foot long to the shaft of the machine and measuring the pull at a point on the lever precisely one foot from the center of the shaft. The pull in pounds at this point will be the torque in pound-feet, the distance being a single foot. If the pull is measured at any other distance from the center of the shaft, it must be multiplied by that distance (in feet) in order to give the torque in pound-feet.

What is meant by water evaporated in a boiler per hour "from and at 212 degrees?" (2) How is the amount of water evaporated from and at 212 degrees ascertained? R. S. P.

The quantity of water that would be evaporated per hour if the steam were not confined and if the feed-water were delivered to the boiler at a temperature of 212 degs., other conditions remaining unchanged. (2) Subtract the total heat of the feed-water at the temperature at which it is actually delivered to the boiler from the total heat of the steam at the pressure which is maintained, and divide the result by 965.7; this gives what is known as the factor of evaporation. Multiplying this factor by the amount of water actually evaporated gives the amount that would be evaporated "from and at 212 degs.," with all the conditions the same, except the steam pressure and feed-water temperature. All engineers' handbooks contains tables of evaporation factors, so that the preliminary calculation is not necessary.

Why is the average height of half a sine curve $\frac{2}{\pi}$ times its maximum height? J. H. C.

The area enclosed by half of a sine curve and its base line is twice as great as that of a square having sides equal to the height of the curve. Taking this height as unity, the area enclosed by the curve would be 2. The datum line of a complete sine curve, comprising a loop above the line and one below it, is equal in length to the circumference of a circle having a radius equal to the height of the half curve above the datum line, which is obviously 2π times the height of the curve. The base line of the half curve which lies above it is, therefore, equal in length to π times the height of the curve. Dividing the enclosed area by the length of the base line gives the average height of the curve. For example, if a half sine curve be drawn to a height of 3 ins., its base line will be 3π ins. long. The area enclosed by the curve and the base line will be twice that of a square having sides 3 ins. long, or 18 sq. ins. The average height of the curve will, therefore, be:

$$\frac{18}{3\pi} = \frac{2h}{\pi},$$

h being the height of the curve.

A NEW ELECTRIC LOCOMOTIVE HEAD-LIGHT.

A trial is in progress on the Chicago, Milwaukee & St. Paul Railway, between Chicago and Milwaukee, with a new arc head-light, and while a number of accounts of these tests have appeared in the daily press, a brief description of some of the technical details will, no doubt, be of interest. Fig. 1 is a view of the head-light complete, showing also a steam turbine which is direct-connected to a small dynamo not visible in the picture. Besides throwing the light ahead of the locomotive there is also a reflector which serves to throw a ray straight up, which is visible for many miles. Fig. 2 shows the interior construction of the head-light. The mechanism has a series coil for striking the arc and a shunt coil for feeding. The point of interest in connection with this type of electric head-light is that the negative electrode of the arc is a star-shaped copper wheel, only the positive electrode being of carbon.

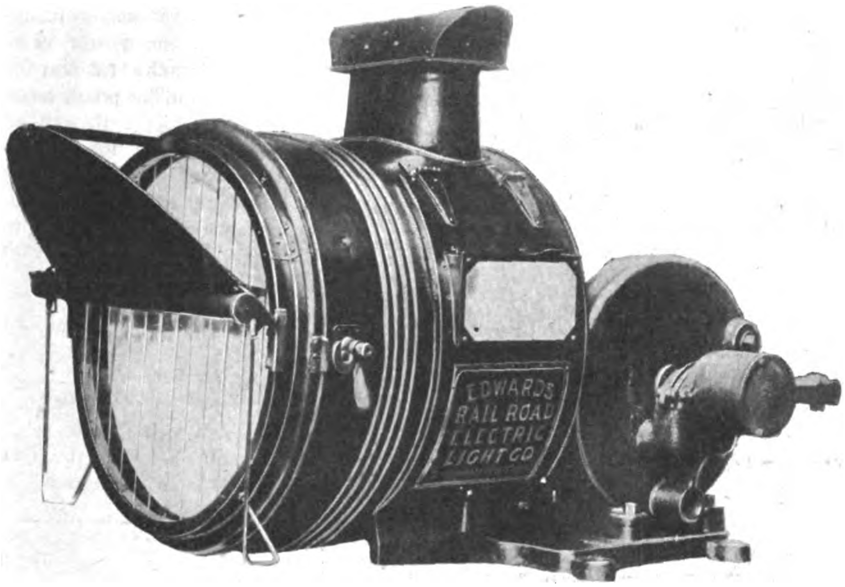


FIG. 1.—ELECTRIC LOCOMOTIVE HEAD-LIGHT.

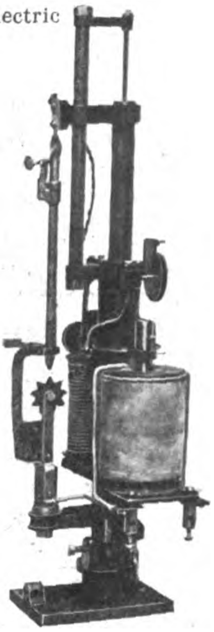


FIG. 2.

With a normal arc having 50 volts difference of potential across its terminals, this copper negative would, of course, be rapidly destroyed. In this apparatus, however, only 30 to 33 volts potential difference is maintained across the arc, and this, of course, results in a short hissing arc. With an arc of this length considerable graphite is deposited on the negative electrode, which to a certain extent serves to prevent rapid wearing away of the metal. The object of the arrangement is, of course, to keep the arc in a proper focus without attention on the part of the engineer. The focus on a powerful electric head-light must be maintained very closely in order to secure good results on the forward end of a locomotive, where the light is inaccessible during ordinary operation. It is, of course, impossible for the engineer to adjust the focus except when starting the lamp and, therefore, it is of the greatest importance to have a device by which the arc will be maintained in a constant position.

The dynamo that supplies the current has a differentially-wound field, the series coil opposing the shunt coil, so that an excessive current passing through the series coils, as in the case of a short-circuit, results in weakening the field. The turbine and dynamo operate normally at 2000 r.p.m. The outfit is built by the Edwards Railroad Electric Light Company, Cincinnati, Ohio.

THE MOORE TELEPHONE SYSTEM.

For several years past there has been in operation in the eastern part of Michigan a telephone system which has enjoyed the rather peculiar distinction of being operated in connection with both the system of the Michigan Bell Company and the network of most of the independent companies. The apparatus used on this system was built by the Moore Telephone Manufacturing Company, Caro, Mich., and the principal features of the system are illustrated herewith.

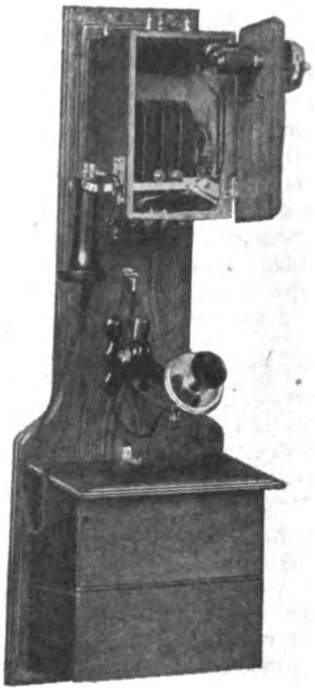


FIG. 2.—MOORE WALL SET.

Fig. 1 shows a desk outfit comprising a magneto-generator, extension bell and the usual desk form of instrument. Fig. 2 shows a wall set, which is of standard construction. The induction coil of the desk outfit is located in the ringer box instead of being in the base of the transmitter stand, where it is usually placed. The transmitter is of the carbon ball type; the face-piece is of turned brass in order to secure a higher degree of accuracy than is possible with pressed or spun work,

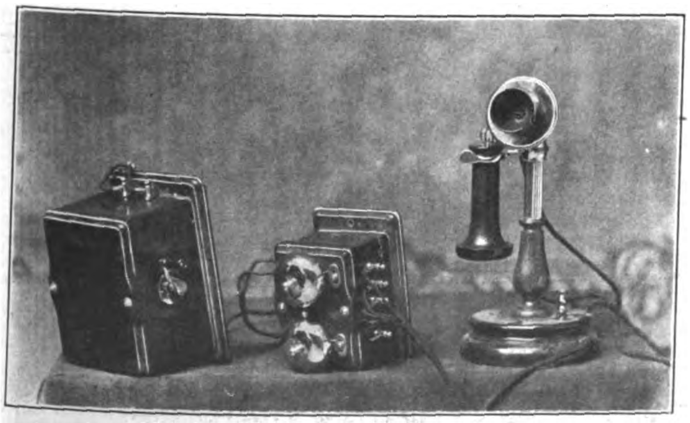


FIG. 1.—MOORE DESK OUTFIT.

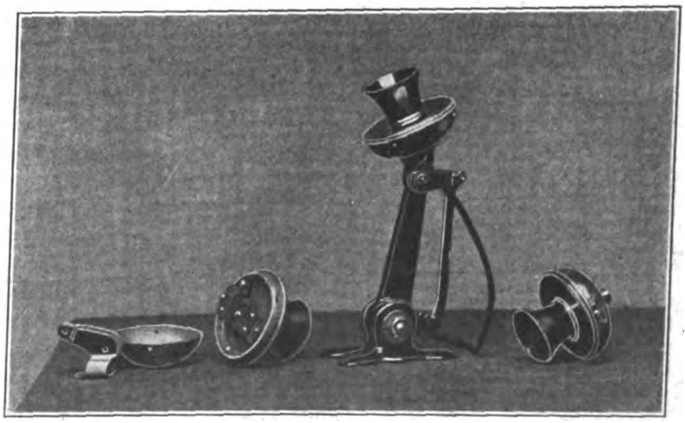


FIG. 3.—TRANSMITTER ARM AND DISMANTLED TRANSMITTER.

and the diaphragm is of carbon. The transmitter arm used with the wall set has a parallel-motion link which maintains the direction of the transmitter mouthpiece constantly the same, whether the transmitter be raised or lowered. This arm is shown more plainly in Fig. 3, together with a dismantled transmitter.

The receiver is of the multipolar type, this form being adopted in order to distribute the magnetic action on the diaphragm over a larger surface than is ordinarily the case. The receiver hook-switch is similar to the well-known Watson hook-switch of the Bell Company, and is made of hard-drawn copper, brass and bronze. The magneto-generator is provided with a laminated armature core, the advantages of which are too well-known to need recapitulation.

The Moore switchboards are built chiefly with a view to the requirements of small exchanges—those having 300 drops or less. Fig. 4 shows a compact switchboard for 280 drops, and Fig. 5 shows a strip of 10 drops, which is the standard form of mounting. The shutters of the drops are extra heavy, so that when they are used to close in bell connections the contact is firm and reliable. The jacks are made up in rows of 10, corresponding, of course, in center to center distances with the drops.

Fig. 6 shows the operating desk lid of the switchboard thrown back, exposing the listening and ringing keys and the connections. The listening and ringing key is arranged so that it will ring through either plug of a pair, and will cut off positively when the lever is released. No metal parts of the ringing and listening keys are exposed on the top of the desk lid of the switchboard, not even screws. One of these keys is illustrated by Fig. 7.

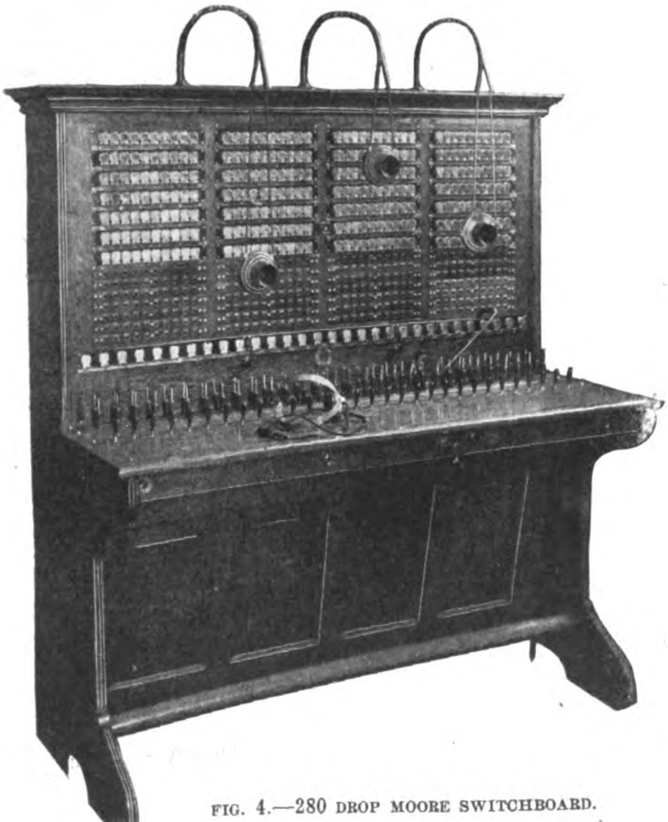


FIG. 4.—280 DROP MOORE SWITCHBOARD.

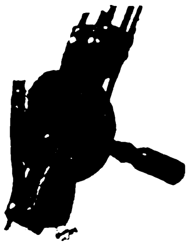


FIG. 7.

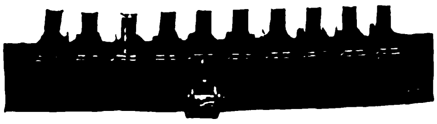


FIG. 5.—STRIP OF MOORE DROPS.

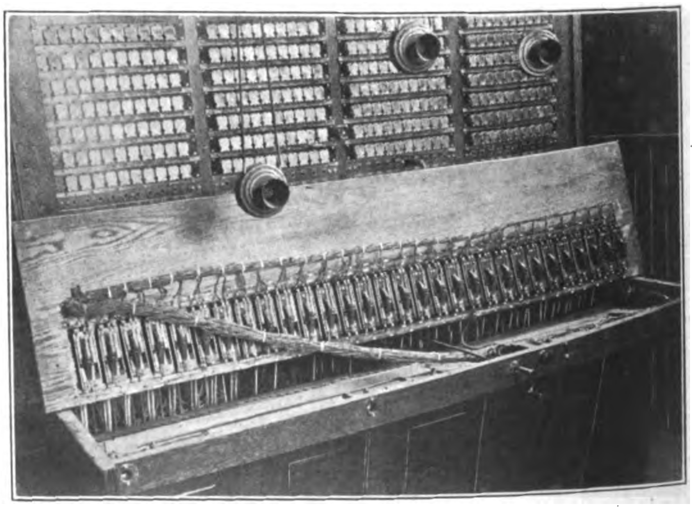


FIG. 6.—MOORE SWITCHBOARD WITH LID THROWN BACK.

COAL PULVERIZER AND AUTOMATIC STOKER.

The method of driving a stream of mingled dust-fuel and air into a furnace where combustion takes place, and of regulating the quantity of fuel and air so as to obtain practically a perfect combustion, is by no means new; but seldom have both the pulverizing and feeding operations been combined in one machine. We illustrate herewith such an apparatus, known as the "Ideal" fuel-feeder, and manufactured by the Ideal Fuel-Feeder Company, of Brooklyn, N. Y. In this machine the coal is pulverized and simultaneously mixed with the proper proportion of air necessary for its complete combustion, upon entering the furnace.

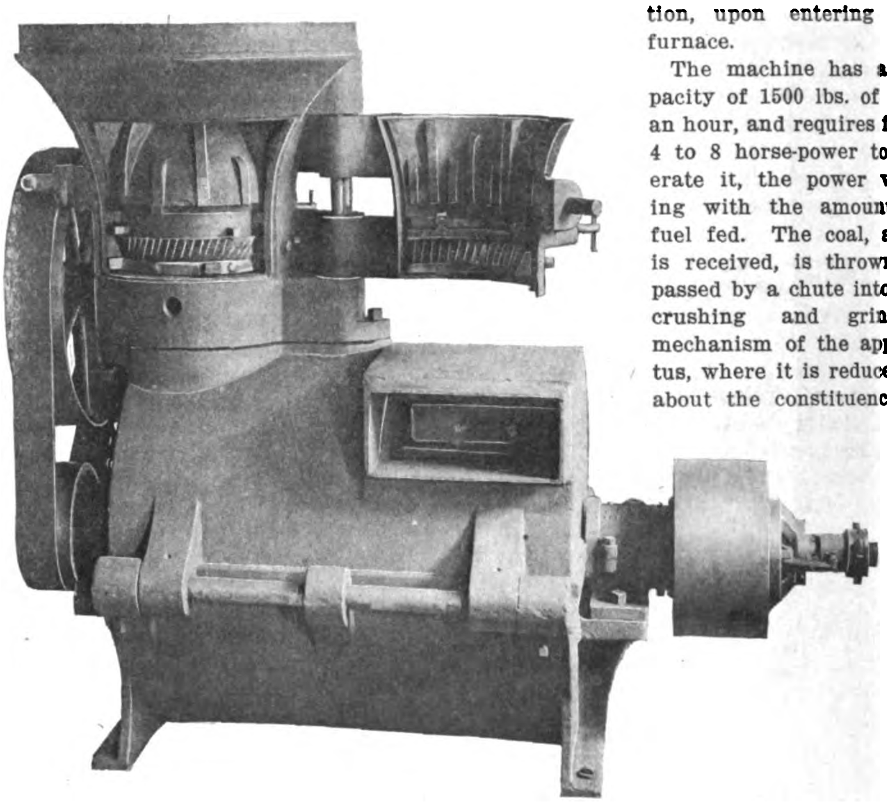


FIG. 1.—IDEAL FUEL-FEEDER.

The machine has a capacity of 1500 lbs. of coal an hour, and requires from 4 to 8 horse-power to operate it, the power varying with the amount of fuel fed. The coal, as it is received, is thrown or passed by a chute into the crushing and grinding mechanism of the apparatus, where it is reduced to about the constituency of granulated sugar in two operations. In the first grinding it is crushed to about the size of buckwheat coal, after which it falls through a feed-regulating device into the secondary reducing mechanism or grinder, which is provided with a positive feed preventing clogging or congestion; here it is reduced to the granulated state. From the secondary grinder it passes to the pulverizing apparatus, where it is reduced to an impalpable powder and simultaneously mixed with the proper proportion of air. This mixture passes to the blower or ejector, whence it is discharged through a pipe into the furnace. These operations may be better understood by reference to Fig. 1.

An inspection of the engraving shows one of the doors of the apparatus open, exposing a portion of the revolving internal mechanism. The cone-shaped casting with heavy projecting ribs crushes the coal to the size of buckwheat. The coal then drops upon the circular projecting flange shown on the door of the apparatus immediately below the heavy projecting ribs. A closer examination of this circular projecting flange reveals what appears to be a very smooth pin. This pin, together with a similar one on the opposite side of the crusher, may be pulled out and the opening in the circular flange increased. By this means the amount of coal passing through is regulated.

Just above this circular flange will be noted two projecting pieces of metal, set in the smooth "belt" of the revolving cone. These are termed "sweeps," and serve to sweep the coal around on this circular flange. When the coal passes through the opening in the circular flange, mentioned above, it drops to the grinder below, which, it will be noted, consists of a circular corrugated grinding face, which revolves and acts in conjunction with the stationary corrugations on the interior wall of the casing; the two sets of corrugations are disposed angularly with respect to each other. This provision is made not only for the purpose of further reducing the size of the coal, but also for positively feeding it downward, so that congestion will not take place. Aside from the crushing and grinding apparatus the rest of the machine is comparatively simple.

Ignition takes place within a few inches of the furnace doors, and the fire resembles somewhat that resulting from the use of oil. The feed being uniform, the fire is, of course, also uniform. The furnace door is never opened, and hence the boiler is not subjected to the cold charges of air incident to hand firing. There is an absence of clinkers and smoke, and the ash, representing the non-combustible matter in the coal, falls into the space back of the bridge wall, whence it may be removed once or twice a week. The manufacturers claim, as a result of tests made, an evaporation of from nine to eleven pounds of water per pound of coal, depending on the quality of the fuel. Fig. 2 shows the method of connecting the feeder to the boiler, and the addition to the usual boiler setting of a solid brick arch extending from the front wall of the combustion chamber underneath the boiler a distance of about 45 ins. towards the bridge wall. This arch, it is explained, makes it possible to utilize gases that would otherwise pass off unconsumed.

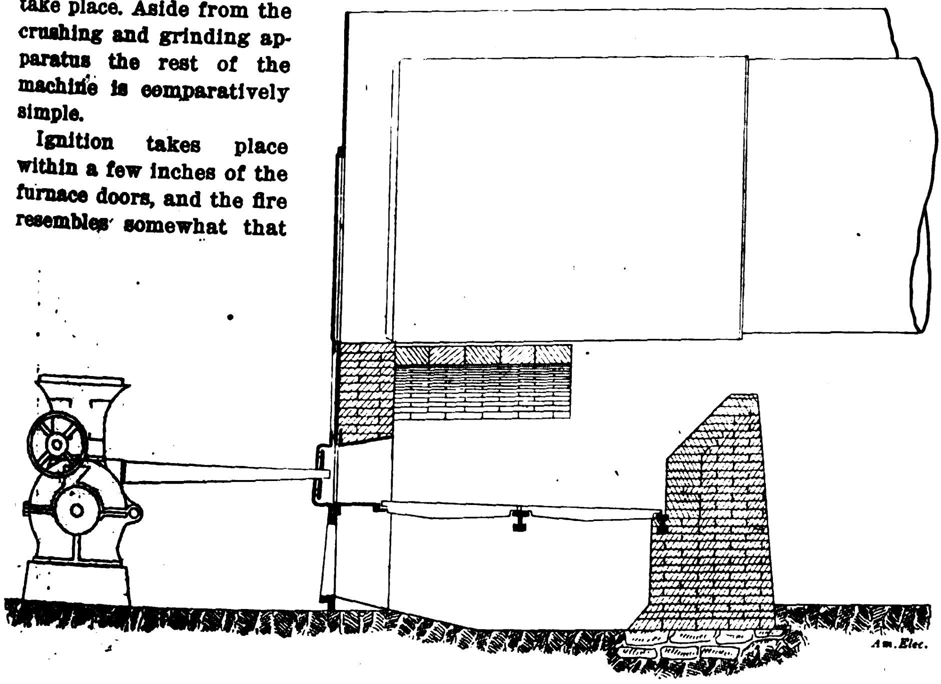


FIG. 2.—METHOD OF CONNECTING FUEL-FEEDER TO FURNACE, AND BRICKWORK OF LATTER.

CLARK AUTOMATIC TELEPHONE SWITCHBOARD SYSTEM.

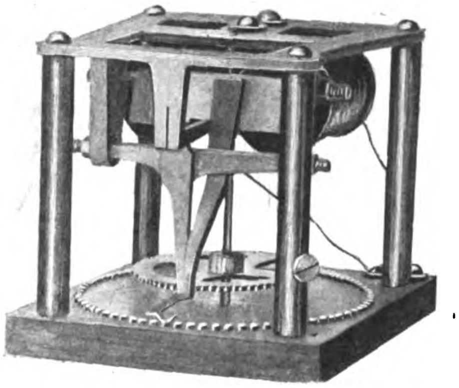


FIG. 1.—AUTOMATIC SWITCH.

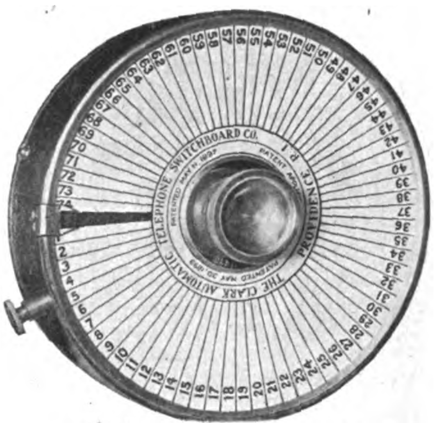


FIG. 2.—SUBSCRIBER'S DIAL.

The immense convenience to industrial establishments of intercommunicating telephone systems is too well known to require expatiation here on that point. It is noteworthy, however, that the systems which come strictly within the class indicated by the term "intercommunicating" are limited in practicalness to plants of from 15 to 20 stations. When 20 stations are exceeded it is usually deemed expedient to put in a miniature exchange system with a central switchboard and operator. For plants of this class the automatic switching system built by the Clark Automatic Telephone Switchboard Company, Providence, R. I., is peculiarly well adapted. This system gives practically all of the advantages of the manually-operated central switchboard without involving the expense of a switchboard operator.

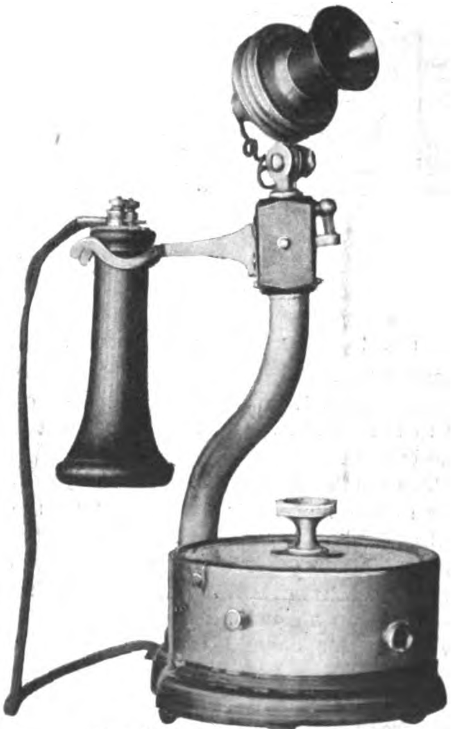


FIG. 3.—CLARK DESK SET.

The system consists broadly of a switchboard made up of a number of automatic switches, one of which is illustrated by Fig. 1; a subscriber's dial, illustrated by Fig. 2, the function of which is to select the number to be called up; and the usual subscriber's telephone set, consisting of a magnet, transmitter and receiver. The automatic switch has mounted on its base 75 contact points, arranged in a circle, each contact point being connected to the service line of one station. The mechanism is of the well-known step-by-step type, consisting of a magnet and armature so arranged that each impulse of current sent through the magnet coils moves the

toothed wheel shown in the center of the structure one notch forward. This wheel carries a contact finger, which travels over the individual line contacts. Consequently, one impulse of current in the magnet coils will carry the contact finger to button No. 1, three impulses will carry it to button No. 3, and so on throughout the entire range.

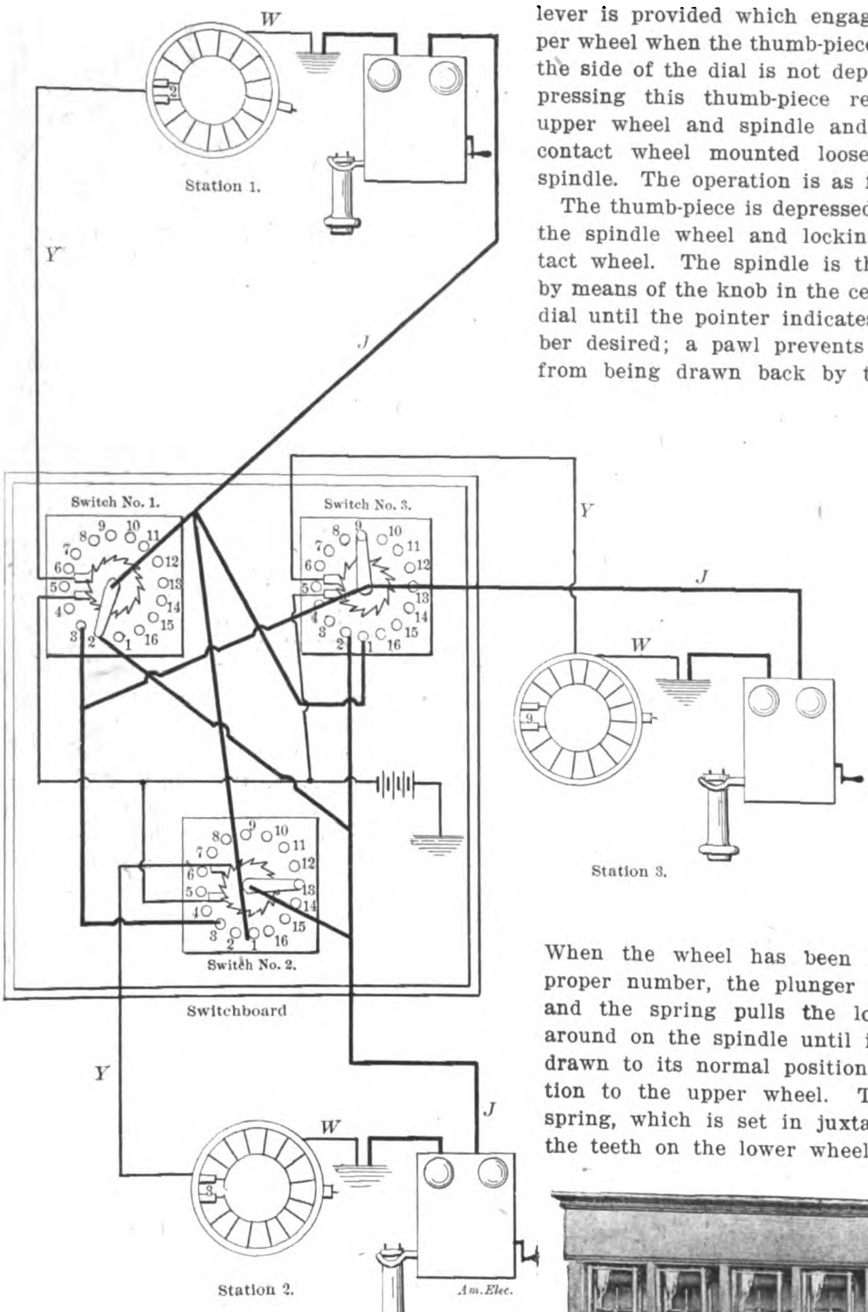


FIG. 4.—DIAGRAM OF CONNECTIONS.

The number of impulses transmitted to the switch magnet is determined by the subscriber's selective dial. The mechanism of this dial consists of two brass wheels, each having 75 teeth and being mounted on a central axle with a smaller wheel, which engages a retarding mechanism to prevent excessive rotative speed. **The lower of the two main wheels referred to is mounted loosely on the central spindle, and a small contact spring is arranged so that when this wheel revolves the spring touches the teeth of the wheel successively and closes the circuit. The upper of the two wheels is secured to the spindle, which is revolved by means of the knob on the outside of the dial. The two wheels are connected by a spring, so that when the upper wheel is turned forward the spring tends to draw the lower wheel around with it. A locking** lever is provided which engages the upper wheel when the thumb-piece shown on the side of the dial is not depressed. Depressing this thumb-piece releases the upper wheel and spindle and locks the contact wheel mounted loosely on the spindle. The operation is as follows:

The thumb-piece is depressed, releasing the spindle wheel and locking the contact wheel. The spindle is then turned by means of the knob in the center of the dial until the pointer indicates the number desired; a pawl prevents the wheel from being drawn back by the spring. When the wheel has been set at the proper number, the plunger is released and the spring pulls the lower wheel around on the spindle until it has been drawn to its normal position with relation to the upper wheel. The contact spring, which is set in juxtaposition to the teeth on the lower wheel, will have **been passed and touched by the number of teeth indicated on the dial.**

For example, if it is desired to call up No. 18, the plunger is depressed, releasing the index wheel and locking the contact wheel, and the index wheel is then turned until the dial indicates 18. The index wheel will have then been turned a distance of 18 teeth, and when the plunger on the side of the case is released, the spring connecting the two wheels will draw the contact wheel around until 18 of its teeth have touched the contact finger and sent 18 impulses to the automatic switch corresponding to the number of the station calling up. This automatic switch receiving 18 impulses will have its contact finger carried around to the 18th contact button, to which station No. 18 is connected. That station is then called up in the usual manner, which may be by magneto or battery signal, according to the owner's preference. Fig. 4 is a diagram of connections showing three stations of a 16-station plant, which, taken with the foregoing explanation, will make the operation of the system clear.

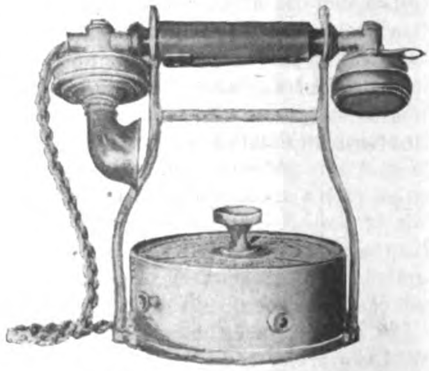


FIG. 5.—MICROTELEPHONE SET.

The subscribers' instruments are mounted in any of the standard forms. Fig. 3 shows a desk set comprising the ordinary types of instruments and having the selective dial mounted on the base; Fig. 5 shows a set in which the familiar hand microtelephone is used.

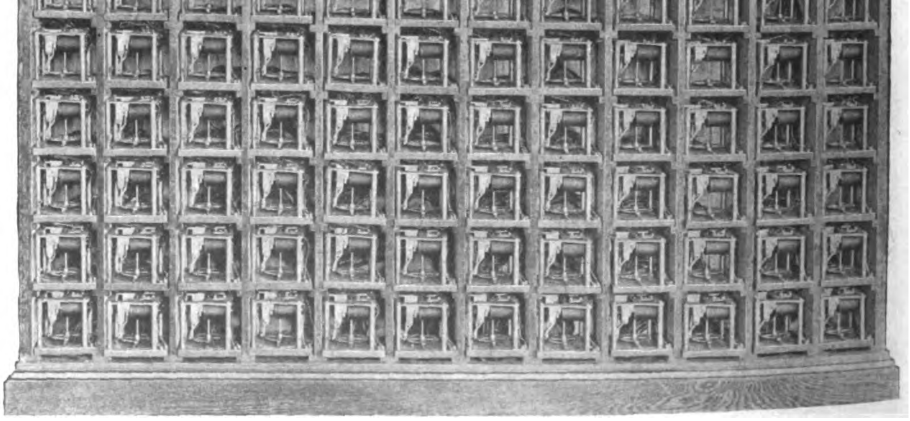


FIG. 6.—COMPLETE CLARK SWITCHBOARD FOR SEVENTY-TWO STATIONS.

Fig. 6 shows a complete switchboard for 72 stations, there being one automatic switch, of course, for each station; a switchboard of this size occupies a space 5 ft. long, 3 ft. high and 1 ft. deep.

New Apparatus and Appliances

DYNAMO-ELECTRIC MACHINES FOR TELEPHONIC SIGNALING.

The gradual introduction of the central energy system has witnessed an increasing demand for dynamotors and motor-generators for the purpose of transforming the available electric current into a current of proper character to perform the work of signaling or ringing. The function of the machine is to perform at the central office the work heretofore performed by the individual magneto. A form of dynamotor constructed by the Holzer-Cabot Electric Company of Boston, Mass., especially for this class of work, is shown by Fig. 1 herewith. It is intended for use where the supply is direct current. The armature is double wound, one winding taking current from the primary circuit and driving the machine as a motor, and the other winding operating as in a dynamo and delivering current for ringing. The primary or supply circuit and the secondary or ringing circuit are, however, brought very close together in the armature of the machine, and when the voltage is as high as 500 or 600 there is danger of a cross-connection forming between the two armature windings. For this reason it is considered preferable when using voltages above 220 to use two machines coupled and insulated from each other.

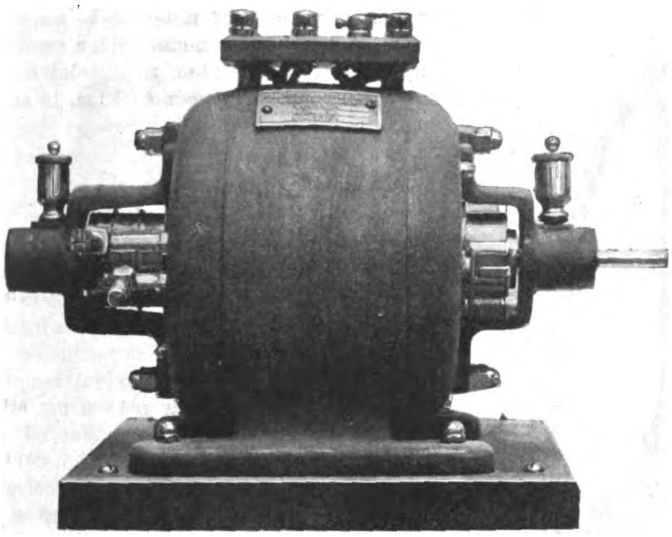


FIG. 1.—DYNAMOTOR FOR TELEPHONE SIGNALING.

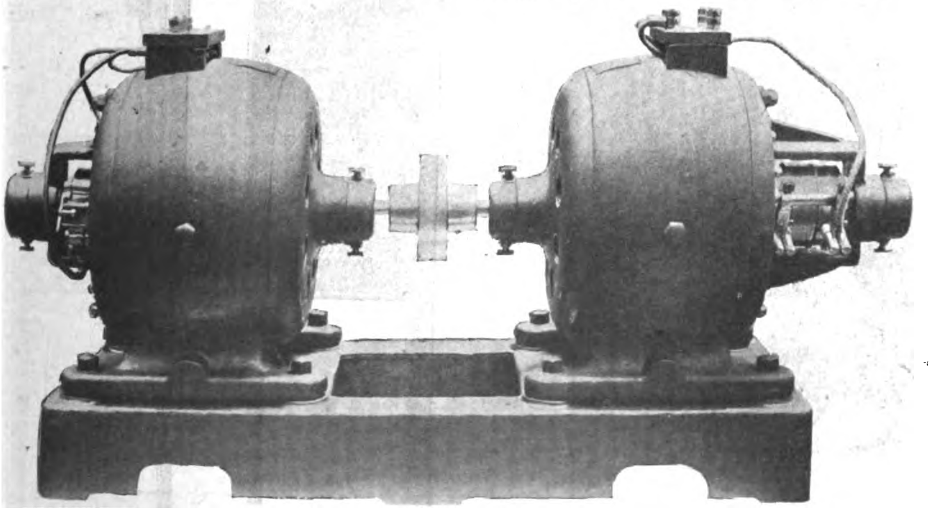


FIG. 2.—MOTOR-GENERATOR FOR PRIMARY VOLTAGES OVER 220 VOLTS.

Such a combination is shown in Fig. 2. Here the two machines are mounted on a light iron base and connected by a flexible coupling. The generator delivers an alternating and a pulsating current, and has an output of 250 watts at 1000 r.p.m. Motor-generators and dynamotors for charging batteries are similar to this machine, only that the collector rings are replaced by a commutator and the pencil brush-holders are replaced by box brush-holders, made especially for carrying heavy currents. The pole-pieces and poles of these ringers are made of soft steel, and the armature is of the laminated and slotted drum type. The brush studs are held by a ring fitted in a machined seat in the end cap. The brush-holders, commutator, and collector rings are designed for minimum attention and long wear.

The third collector ring shown on the secondary end is a split ring, which is connected to the secondary winding in such a way that it gives a pulsating current; *i. e.*, it delivers but half of each cycle. This pulsating current is used in selective party line signaling in connection with a bell of special design, which responds only to the pulsating half wave. The alternating current winding is usually proportioned to give 80 volts and, as the machine is bipolar and the speed usually 1000 r.p.m., the frequency is ordinarily 16, which, it is claimed, will ring satisfactorily through a toll line 100 miles long. The pulsating e.m.f. is usually about 60 volts. The machine shown operates only on direct-current circuits; where only alternating current is available it is necessary to use a combination of two machines connected together, one being an alternating current motor and the other being a direct-current generator. This set is somewhat similar in appearance to the one here shown.

STROMBERG-CARLSON MINE AND RAILWAY TELEPHONE SET.

A mine and railway telephone set which is especially intended to meet the conditions of both bad weather and severe usage is shown by Figs. 3 and 4; this outfit is made by the Stromberg-Carlson Telephone Manufacturing Company, Chicago. The iron box which protects the telephone proper is claimed to be absolutely water tight and weather-proof. The ringers are mounted in the upper part of the box, with an opening at each side so that the call may be heard at some distance from the telephone. These openings are so arranged that the apparatus is protected not only from the weather, but also from mechanical injury, due to a mischievous desire on the part of anyone to insert sticks through the opening or to meddle otherwise. The talking and calling apparatus is located in the lower portion of the box and particularly arranged to suit the purposes for which the telephone is supplied. In mines and in bridged railway telephone service a wooden box contains all of the apparatus. Ample space is provided in the outer box for the removal of the receiver and the turning of the crank. Where the apparatus is mounted for police-signal and fire-alarm work, the usual arrangement of mounting the parts separately is carried out. The cover of this box fits tightly over a rubber gasket and when the door is closed the box is air tight and may be placed in exposed locations with impunity. Four-inch gongs are employed; experience having demonstrated that bells of this size can be heard at a sufficiently great distance for all practical purposes.

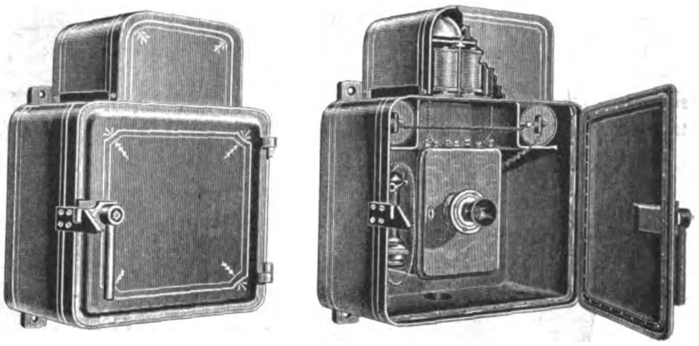


FIG. 3.—STROMBERG-CARLSON TELEPHONE SET.—FIG. 4.

KELLOGG TRANSMITTERS AND RECEIVERS.

In the familiar solid-back transmitter the cell containing the electrodes and granular carbon is fastened rigidly to the solid back. The front electrode being secured to the diaphragm, naturally vibrates with it and acts as a piston to vary the pressure on the granules, and thus produces the transmission. The Kellogg transmitter is of the reverse solid-back type, and is said to possess besides the advantages of a well-designed solid-back transmitter some advantages of its own. The cell containing the electrodes and granular carbon is formed in, and constitutes a part of, the diaphragm. The granules are well shaken up, since the entire cell vibrates with the diaphragm, and this, it is stated, not only prevents packing, but produces a wide range of variation in resistance, which is conducive to powerful transmission. As the electrodes, which are made of special polished carbon and granular carbon, form a vital part of the transmitter, they are sealed by riveting a retaining ring over a thin mica disc, shown in Fig. 5, which is an auxiliary diaphragm. These parts together constitute the piston electrode and regular diaphragm. The bridge to which the back electrode is fastened is made from a heavy strip of brass, as shown by Fig. 6, which gives a rigid construction. The back or retaining case, shown by Fig. 8, is spun from heavy sheet brass, and the mouthpiece is made from pure hard rubber and provided with a perforated partition, as shown in Fig. 7, to protect the diaphragm. All exterior parts of the transmitter are heavily nickeled.

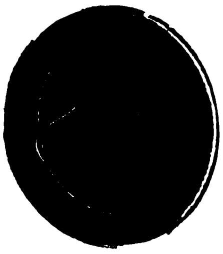


FIG. 5.

FIG. 6.

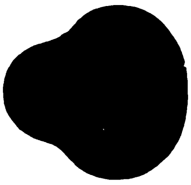


FIG. 7.

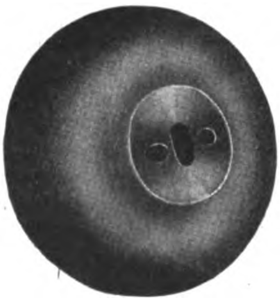


FIG. 8.—BACK FOR RETAINING CASE.

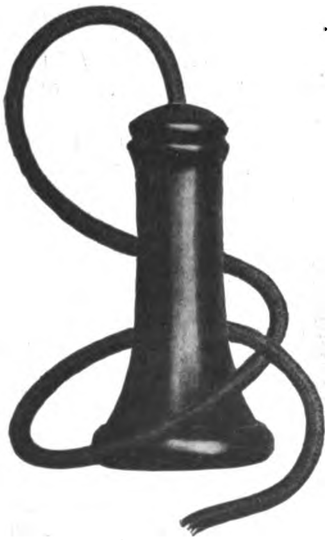


FIG. 9.—RECEIVER.

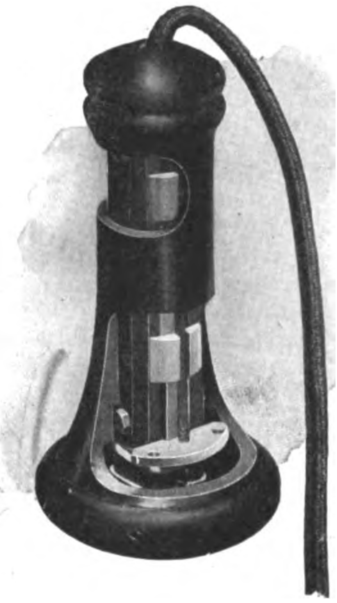


FIG. 11.—COMPLETE RECEIVER, SHOWING THE PARTS IN POSITION.

The receiver is shown by Fig. 9. It is reinforced by an extra ring at the tail cap to render breakage at this place almost impossible. The binding post nuisance has been eliminated by omitting binding posts entirely. Instead of these, connectors are carried to a hard fiber insulating block on the permanent magnet, as shown by Fig. 10, which depicts the receiver dismantled. Another view, showing a portion of the receiver cut away so as to expose the parts in normal position, is given by Fig. 11. The connections are completely enclosed within the shell, and are readily accessible by unscrewing the tail cap. The cord passes through a small hole in the latter, and is secured to a metal eye on the magnet in a manner which relieves the conductors of all strain. Any standard cord may be used with the receiver. All parts of the shell are composed of a high grade of hard rubber. The magnets are made of steel, of course, and the pole-pieces of soft Norway iron, securely fastened to the magneto and carrying coils of silk-covered magnet wire. A heavy cast metal bridge secures the magnet to the shell at a point near the diaphragm, as shown in Figs. 10 and 11.

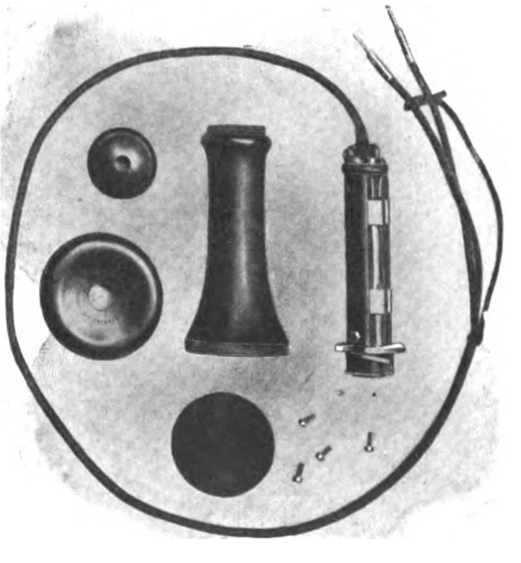


FIG. 10.—RECEIVER DISMANTLED.

SMALL PLANT SWITCHBOARDS.

The continued increase in the use of electricity, especially in small units for lighting and power, has brought about an extensive demand for switchboards to be used in connection with such small installations. The design and construction of such boards to meet the special requirements of each plant has proven not only expensive, but very inconvenient on account of the time required. In order to obviate the necessity for special designs in cases of this sort, the General Electric Company has standardized a complete line of small plant switchboards, in a variety of capacities. The line includes a complete series of combination generator and feeder panels for low potential direct current service in small plants, one of which is illustrated herewith. Each of these panels is a complete standard switchboard and is not intended for combination with other panels. Fig. 12 shows a front view

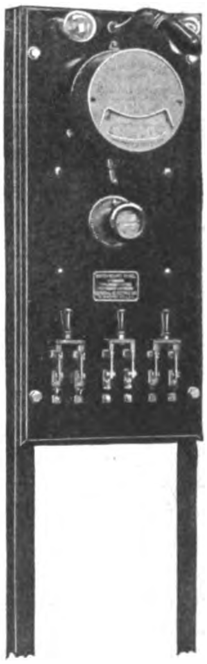
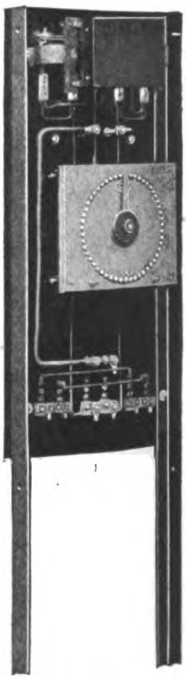



FIG. 12.—G. E. SWITCHBOARD.—FIG. 13.

of the switchboard, and Fig. 13 is a rear view of the same.

These small plant switchboards are uniformly made to provide for one generator and two feeder circuits. The material used in the construction is black enameled slate, 1½ ins. thick, especially selected with reference to freedom from impurities likely to impair its insulating qualities. After being baked perfectly dry, the slate is covered with enamel, each layer being baked on and rubbed down, and a final hand polish is given which results in a hard brilliant surface.

The height of the slate panel is 36 ins. for all capacities; the width varying from 16 ins. to 20 ins. depending upon the capacity. All exposed metal parts on the front of the board except live copper have black oxidized finish.

Two methods of support are employed, either of which is supplied according to the requirements; one is known as the angle iron support; the other, the bracket support. In the first method, the panel is supported on angle irons 40 ins. from the floor; the angle iron being provided with turnbuckles and clevises for making wall attachment. In the second method, the panels are secured to the wall by bracket supports independent of the floor.

On these switchboards, the General Electric "Form D" lever switch is used. This conforms with the Underwriters' requirements, and has solid forged copper clip-blocks and studs; the blades are rigidly fastened to the cross bars. The blades, clip-blocks and studs are all given a ground finish. All switches are provided with fuses.

On these panels, the ammeter is permanently connected in the generator circuit; the instrument supplied is the company's round dial indicator, which is particularly adapted for long continued hard service. Its few parts are strongly constructed, and having no springs, it is particularly free from liability to change.

The scale is of a most satisfactory character. When desired, voltmeters of a general design similar to the ammeters can be furnished.

FLUSH RECEPTACLE AND PLUG.

The flush receptacle and plug shown by Fig. 14, herewith, are two of the most recent productions of the Marshall-Sanders Company, of Boston, Mass. They were designed in order to provide finished outlets in the floors and base-boards of large office buildings so that lights could be provided for desks set in almost any position, and at the same time to correspond with the fittings and finish of the rooms. The plug and receptacle are made of porcelain and brass, amply heavy for the current usually required, and the receptacle fits the standard boxes for push-button switches of all manufacturers. As shown in the engraving the receptacle is literally flush whether in or out of service, the two lids closing closely around the cord when the plug is within the receptacle.

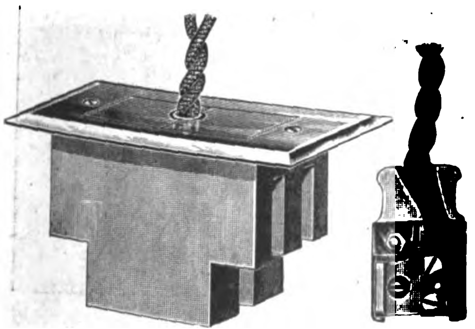


FIG. 14.—FLUSH RECEPTACLE AND PLUG.

DAVIDSON VENTILATING FAN.

Fig. 17, herewith, shows the Davidson belt-driven ventilating fan outfit made by the Massachusetts Fan Company, of Boston, Mass. In this machine, the blades are attached to a long central cast-iron hub by means of heavy wrought-iron clips threaded and screwed into the hub at two points and securely riveted to the blades. This makes the angle of the blade with the hub positive and permanent. The outer ends of the blades are attached by rivets to a heavy wrought-iron running ring, which is in turn attached to one end of the cast-iron hub by five radial wrought-iron braces shouldered and riveted to the running ring and screwed into the hub. This construction makes the fan very rigid. The bearings are of the self-oiling type, lined with babbitt metal and having large oil reservoirs cored into the lower half. The caps are adjustable and the wear on the bearings may be compensated for by screwing down the screws holding the cap in place.

ALTERNATING-CURRENT CEILING FAN.

Figs. 15 and 16 show the Tuerk alternating-current ceiling fan, made by the Hunter Fan & Motor Company, of Fulton, N. Y. In this machine a high-speed motor is used, and a speed reducing gear is placed between the motor spindle and the fan blades. The latter are attached to the lower part of the casing of the machine, which, of course, revolves. Two leather faced friction wheels mounted on short individual spindles transmit the motion of the armature spindle to the casing. The machines are furnished with two or four blades. In the latter type of machine, two of the blades are fixed rigidly on the spindle, and two are provided with a blade adjuster, by means of which the angle of the two blades may be changed while the fan is in motion. A spiral-groove oiling system is supplied, as well as a stopping and starting switch. The fans are built to run on circuits of any frequency from 40 to 140 cycles, and of any voltage from 50 to 230. On the 40 and 50-cycle fans a specially constructed motor is used which gives the fans a speed of 180 r.p.m., with a blade spread of 60 ins. and a power consumption of 90 watts at full speed. The two-bladed fans show a consumption of 100 watts, and the four-bladed fans require from 100 to 110 watts, at full speed.

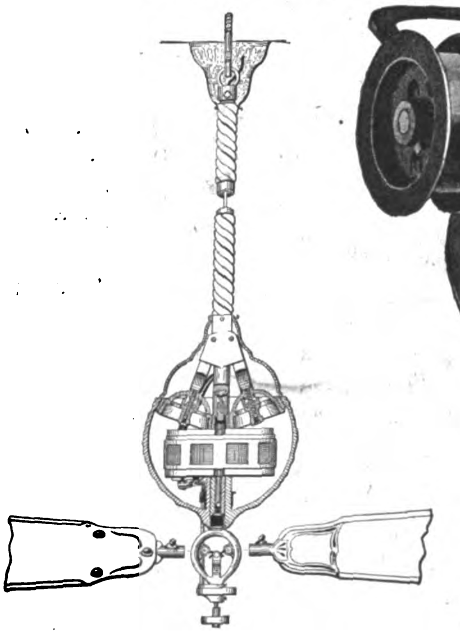


FIG. 15.—SECTION OF TUERK CEILING FAN.

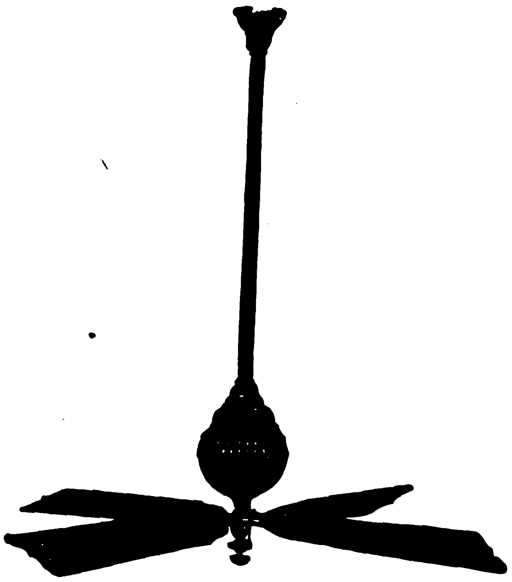


FIG. 16.—TUERK-CEILING FAN.

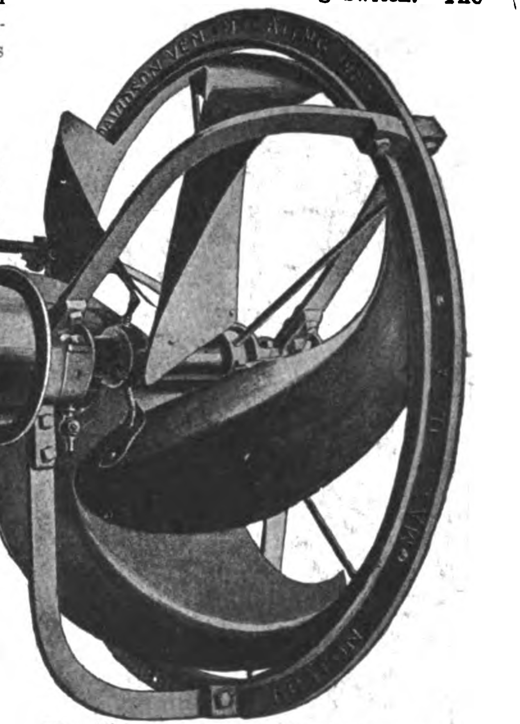


FIG. 17.—DAVIDSON VENTILATING FAN.

RENOLD SILENT CHAIN AND SPROCKET GEAR.

The disadvantages and defects of the ordinary chain and sprocket form of gearing are painfully familiar to all engineers who have attempted to use such gearing for transmitting power in considerable quantity and at high rates of speed. Aside from the noise, a serious objection to the ordinary form of chain gear lies in the fact that after a short period of usage the wearing of the teeth and the elongation of the links produces a disparity between the pitch of the teeth and that of the chain; the result is that if the chain stays on the sprocket most of the pull is transmitted by one or perhaps two of the sprocket teeth, incurring liability of breakage, and greatly increasing the friction of the gear. There soon comes a period when the disparity between the pitches of tne sprocket and the chain causes the latter to refuse to stay on the sprocket at all.

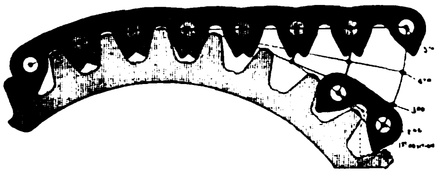


FIG. 18.—CHAIN LEAVING WHEEL.

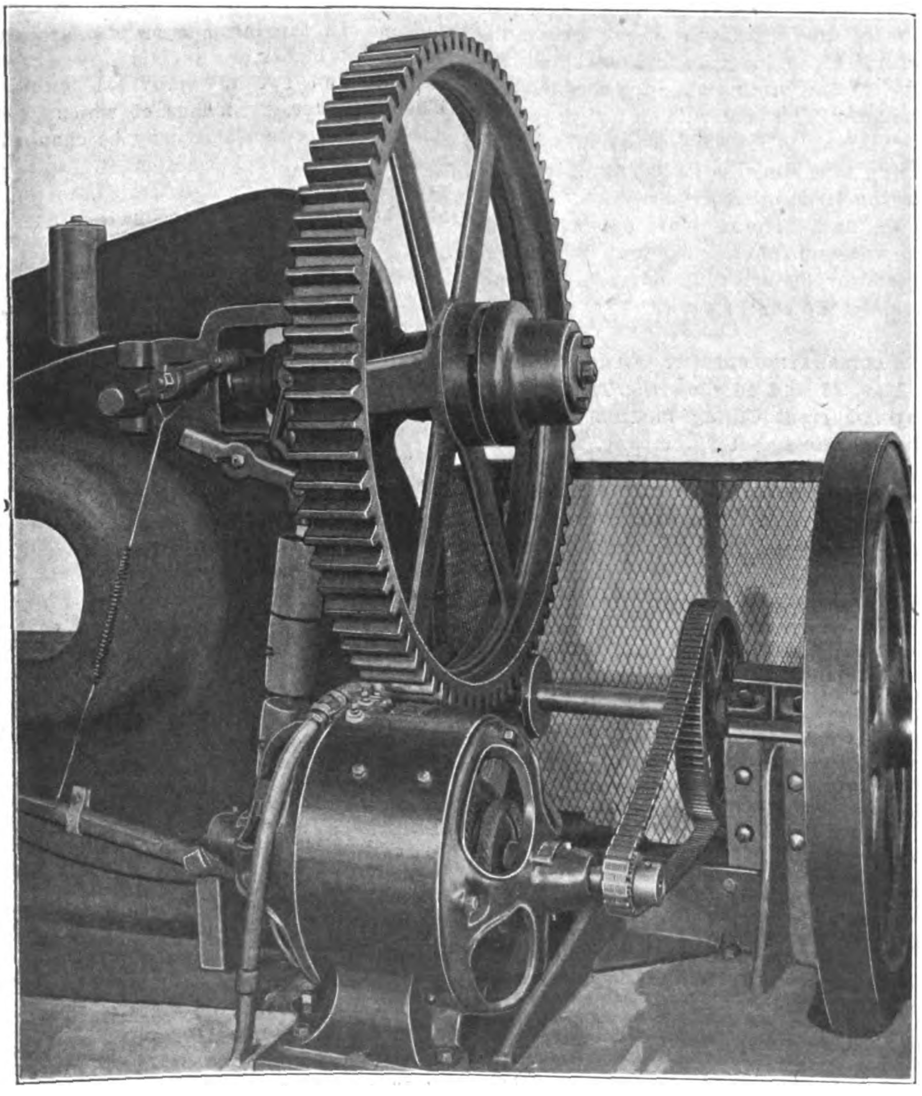


FIG. 20.—PUNCHING PRESS DRIVEN BY MEANS OF RENOLD CHAIN.

The accompanying engravings illustrate the Renold chain, marketed by the Link-Belt Engineering Company, Philadelphia, Pa., and designed for the purpose of eliminating the objections just recited. Referring to Fig. 18, it will be seen that the chain is provided with teeth at the pivotal points of the links, the two teeth at each pivot being so shaped as to conform perfectly to the faces of the teeth on the sprocket wheel when pulled down between tnem. The chain teeth leave or enter the spaces between the sprocket teeth by a rolling instead of a scraping motion, greatly reducing the friction of those operations. Considering the chain to be moving to the right in the illustration, it will be evident that just before each link is unseated the points of the two co-operating teeth are drawn closer together, relieving the pressure on the tooth of the sprocket and enabling the composite chain tooth to be drawn out without scraping the face of the sprocket tooth. It will also be noticed that when the chain teeth are fully seated tney are not drawn entirely down to the root circle of the sprocket teeth, but are seated on the faces of the teeth before their points can touch the bottom of the groove.

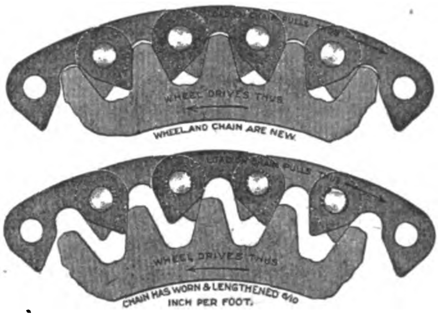


FIG. 19.—CHAIN NEW AND WORN.

This chain, of course, like all others, is subject to wear and elongation, but it is stated that after the chain has lengthened and the teeth have worn to such an extent as would put an ordinary chain out of commission, this form can continue to be worked without giving trouble and still without noise. Fig. 19 represents the meshing of the chain with the sprocket when both are new, and also shows the manner of meshing when the sprocket teeth have worn and the chain has lengthened 6-10 of an inch per foot. Notwithstanding the elongation and wear, just as many chain links find a bearing on the sprocket teeth and continue active as before the lengthening and wearing occurred. The area of seating is, of course, less than it originally was, but the chain continues to operate noiselessly and to transmit power to the full number of sprocket teeth.

It is claimed that the noiseless operation of this driving gear renders it a legitimate competitor of the ordinary belt type, with the following advantages over that form of power transmission: The journal friction is less because the power-transmitting ability of the

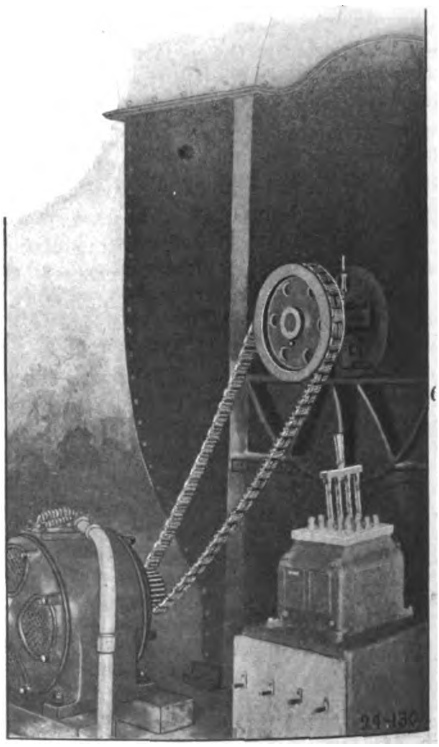


FIG. 21.—CHAIN-DRIVEN FAN.

chain does not depend upon its tension, as in the case of a belt, so that the chain may be run entirely slack; the distance from center to center of two shafts between which power is transmitted by this chain may be made much shorter than in the case of belt transmission for a given velocity, for the same reasons stated with regard to journal friction; the chain may be used in damp and hot places where ordinary belts would be out of the question; for transmitting extra heavy powers, two or more chains may be operated side by side, thus obviating the disadvantage of using extremely wide belts or chains.

Figs. 20 and 21 illustrate the possibilities of the chain for heavy work on short centers, Fig. 20 repesenting a 7½-h.p. electric motor driving a large punching press by means of a Renold chain running at 1160 ft. a minute; and Fig. 21 showing a 10-h.p. alternating-current motor driving a large blower fan which supplies hot air to the evaporaters at the plant of the Natural Food Company, Niagara Falls, N. Y., where this form of transmission is applied to a widely diversified list of machines.

POLE-RAISING APPARATUS.

Fig. 22, herewith, illustrates a machine of somewhat homely appearance, but of an extremely efficient character for raising poles such as are used for overhead electric lines. This machine consists of an A-frame, carrying a wooden telescoping beam, together with means for raising and lowering the beam with relation to the frame; in brief, the apparatus is a mechanically-actuated pike pole. The telescoping pike carries a sheave at its lower end, and a similar one near the upper end, but at right angles to the lower one. At the extreme upper end is the usual spike, flanked by a toothed arm on each side, the function of the arms being, of course, to embrace the pole and prevent its slipping off the point of the pike. A rope or cable is secured at one end to the left-hand leg by the A-frame, as illustrated in Fig. 22, passes down around the sheave at the lower end of the pike pole, and up over a similar sheave near the upper end of the right-hand end of the A-frame, whence it goes to a winch or "crab" mounted on the frame, as shown. It is obvious that turning the handle of the crab in the proper direction will wind up the rope or cable on the drum and raise the telescoping pike.

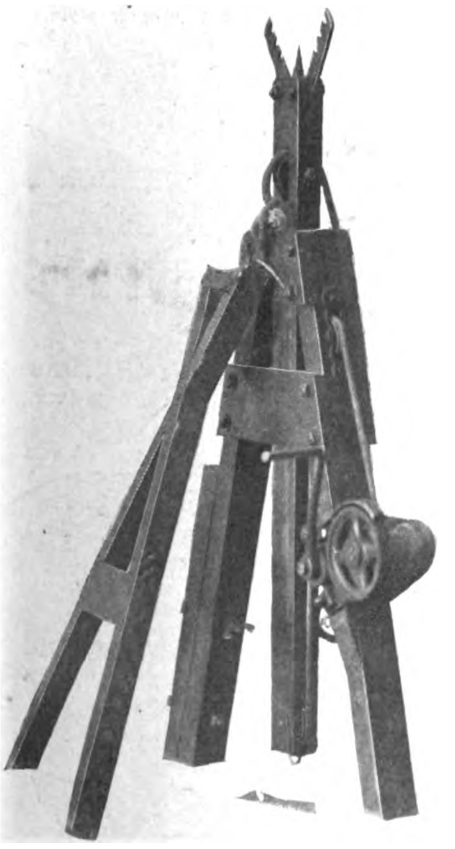


FIG. 22.—POLE RAISER AND DEAD-MAN.

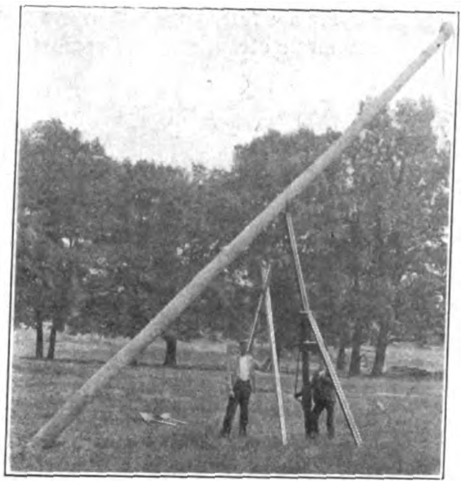


FIG. 23.—POLE PARTLY RAISED.

The method of usage is as follows: The rope shown passing over the upper sheave in the pike is tied in a loop around the end of the pole lying flat on the ground, and the pole is raised by the machine until a "dead-man" can be got under it. Then while the pole is held by the "dead-man," the machine is shifted toward the base and a new hold is taken, this time by the pike and the embracing arms. The operation is plainly illustrated by Fig. 23, which shows the pike at an intermediate stage of a complete raising. The apparatus is manufactured by the Dodd Hoister Manufacturing Company, Anderson, S. C.

MURDOCK CABLE INSULATOR.

A simple cable insulator capable of holding a number of sizes of cable is shown by Fig. 24. The insulator is made by H. D. Murdock, of Pittsburg, Pa., and is in two pieces, each beveled to a square shape at one end. When the two pieces are put together the beveled edges form sides of a square slot between the faces of adjoining insulators, in which the cable is clamped; the opposite grooves are corrugated so as to afford a good grip on the cable. By tightening or loosening the upper half of the insulator all sizes of cable from 300,000 cir. mils to 1,000,000 circ. mils can be securely clamped and held in position. The insulator is made sufficiently strong to withstand the strain of the largest cable it is designed to hold. A smaller insulator of the same design is made to hold cables from Nos. 00 to 300,000 circ. mils.

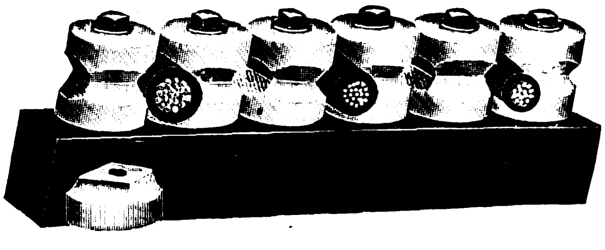


FIG. 24.—MURDOCK CABLE INSULATOR.

THE MICROTELEPHONE IN THE HOSPITAL.

The average person dislikes the idea of going to a hospital while sick or when undergoing an operation on account of being separated from friends and relations. Even the nearest relations are only allowed in the room at certain hours of the day, but with the aid of the telephone conversation could be had at most any time, providing the condition of the patient would permit. Fig. 25 shows a hand microtelephone of the Ericsson Telephone Company, New York, in use under the conditions mentioned. It is a complete transmitter, receiver and switch, of light weight and durable construction, and can be hung at the head of the bed or laid on a stand or chair at the side. Another advantage and a great time saver is the fact that a patient can call up the nurse or attendant whenever needed.

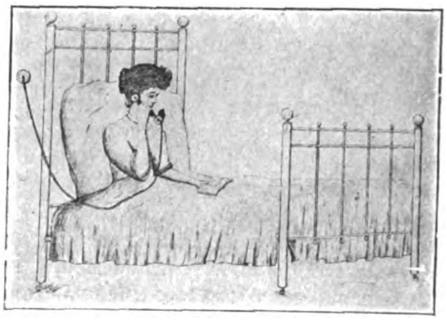


FIG. 25.—MICROTELEPHONE IN HOSPITAL.

CONVENIENT TELEPHONE ATTACHMENT.

To the frequent user of the telephone and others who vainly endeavor to appear at ease when "holding the wire" the device shown by Fig. 27 will come as a sort of boon. This attachment is made by C. H. Newhall, of Philadelphia, Pa., and is easily adjusted to any desk or wall type of telephone. An adjustable collar is placed on the receiver and another having a rod attached is fastened about the neck

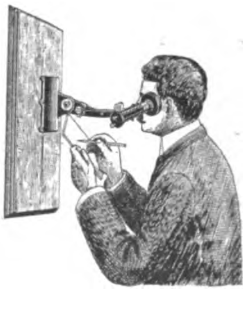


FIG. 26.

of the transmitter, as shown. Neither of these appurtenances interfere with the working of the telephone. When taking the receiver from the hook preparatory to speaking or listening, the plug attached to the band on the receiver is slipped into a hole, or slot, in the bracket attached to the transmitter. When the conversation is ended the receiver is removed and hung up as usual. Fig. 26 shows the attachment affixed to a wall telephone and incidentally illustrates the convenience it affords by leaving both hands free. The attachment is made to fit any style or make of telephone.

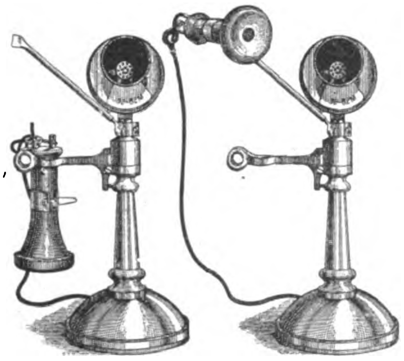


FIG. 27.—CONVENIENT TELEPHONE ATTACHMENT.

INTERCOMMUNICATING WALL TELEPHONE SET.

The accompanying illustrations represent an extremely compact intercommunicating outfit built by the Haines & Noyes Company, Chicago. Fig. 29 shown the complete set, and Fig. 28 is a view of the plug and jack, which is evidently of extremely simple construction. The jacks mounted in the box below the magneto box are connected, of course, to the individual service lines of the various stations, and the plug is connected to the home apparatus. The circuit arrangement is such that even if the plug should be left in a jack, the station can be called up by any other station. The transmitter is the well-known Haines & Noyes No. 5-A instrument. The receiver is of the bipolar "pony" type; the jack spring is of heavy German silver and held in place by a lock-nut, so that the spring cannot twist or work out of position. The outfit here shown is intended for magneto signaling, but it is also made for battery or generator signaling. These instruments are made for any number of stations from 5 to 35, and are finding wide application in apartment houses as well as industrial establishments.

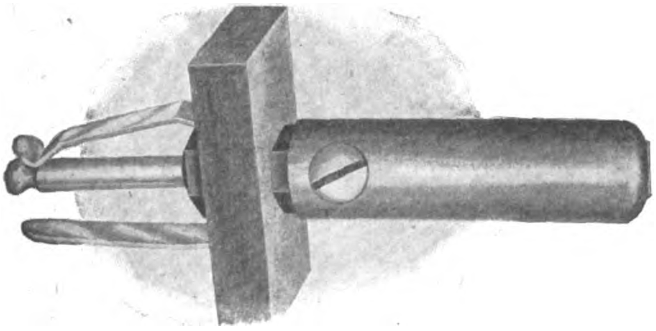


FIG. 28.—HAINES & NOYES' PLUG AND JACK.

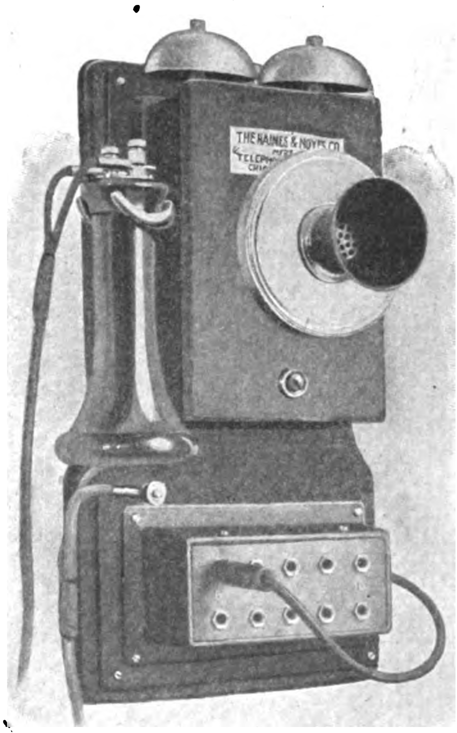


FIG. 29.—INTERCOMMUNICATING WALL TELEPHONE SET.

THE "H. H." STEAM TRAP.

Steam users are fully aware of the value of the automatic steam trap for removing the water which by condensation or any other cause accumulates in steam pipes. Fig. 30, herewith, shows one of the latest of these useful devices, known as the "H. H." steam trap and built by James McCrea & Co., of Chicago, Ill. The manufacturers guarantee it to work successfully under pressures of 1 to 150 lbs., and to deliver against any back pressure which is 5 pounds or more below the steam pressure at the trap. By reference to Figs. 31 and 32 the construction of the trap may be readily understood. It consists of a cast-iron bedplate and removable dome, of sufficient size to accommodate a seamless copper float. Phosphor bronze valves are used, which are easily removable when worn, and the trap being always two-thirds full of water an effective seal is secured. The convenience and ease with which the trap may be opened will be apparent by reference to Fig. 31. By simply loosening the nuts, the bolts holding the dome in place will slip out, releasing the two parts. The traps are made for high and for low pressure and are provided with or without gauge glasses, the advantage of the gauge glass being that it allows one to tell how the trap is working without breaking a steam connection.

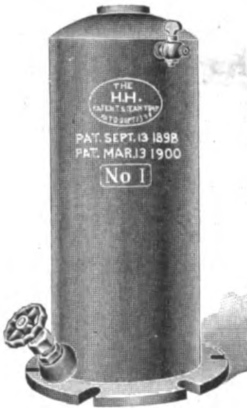


FIG. 30.—STEAM TRAP.

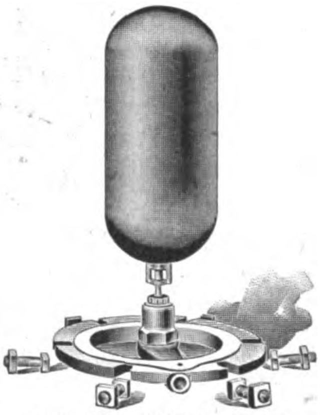


FIG. 31.—COPPER FLOAT.

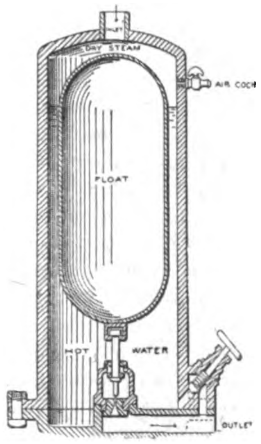


FIG. 32.—SECTION OF STEAM TRAP.

THE HOWES SWIVELING ATTACHMENT PLUG.

Fig. 33, herewith, shows the "Howes" swiveling attachment plug made by the Electric Gas Lighting Company, of Boston, Mass. The plug contains no fuse, and is made of porcelain. The cord is attached exactly as in the older style of plug, and to avoid twisting the cord the top portion should be held stationary while the lower portion is screwed into the lamp socket or receptacle. This is accomplished by turning the corrugated

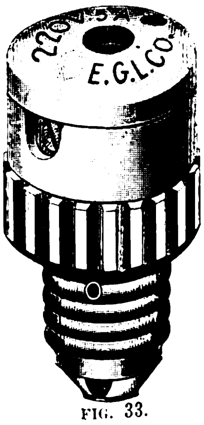


FIG. 33.

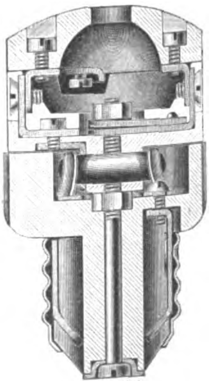


FIG. 34.

porcelain part with the thumb and finger of one hand while the upper cap is held by the other. The difficulty and trouble arising from a twisted and tangled cord is thus avoided. Ample space is provided within the cap for inserting and knotting heavy lamp cord or show-window cord. The device is applicable for electric heating apparatus, and also for use with flexible armored conduit, where the twisting of the conduit results in untwisting the plug and opening the circuit. Fig. 34 is a sectional view of the plug, showing the various parts.

ACME OIL FILTER.

The Acme oil filter, shown by Fig. 35, is a departure from usual practice in that the filtering material is animal boneblack, which has been long known in the arts as an efficient purifier. The containing can is made of heavy galvanized iron, and steam connections are provided in the larger sizes for the purpose of effecting more efficient filtration. Referring to Fig. 35, *A* is the receptacle for the oil to be filtered, which falls of its own weight and rises through the water and filtering material shown at *C*, whence it is drawn off through faucets; *D* is a pan provided for catching the dirt precipitated, *E* is a steam chamber for heating the water, and *F* is an inlet for steam; a similar outlet being provided on the opposite side. The filter is made by W. L. Flower & Co., of St. Louis, Mo.

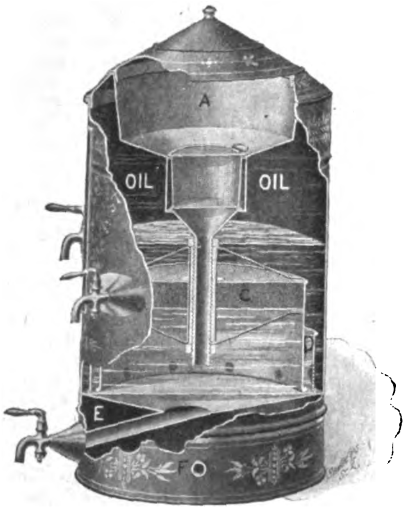


FIG. 35.—ACME OIL FILTER.

STANDARD JUNCTION BOXES.

The standard junction boxes made by Johnson & Morton, of Utica, N. Y., have tablets that can be removed or put in place without disturbing any of the wire connections in the box, which arrangement is well shown in the cross-sectional view given by Fig. 36, herewith. Terminal pieces are fastened upon the sides of the box and hold the connections for the circuits and mains. These pieces extend from the upper surface of the tablet board into the space below the board, where the main and branch wires are attached to them. The upper part of each piece carries a binding screw for the fuse. It will be seen that all of the connections are exposed in the lower part of the box when the tablet board is removed, and that it is a very simple operation to arrange the branches and make connections without regard to the points at which the branch or main wires enter. By simply taking out the fuses the tablet board may be removed and none of the connections disturbed. The whole interior of the box is then exposed for the connection of additional circuits or for making any alterations. Ample room is allowed between the tablet board and bottom of the box to cover the wires with flexible tubing if desired. The boxes have enameled slate tablets and are lined throughout with slate. The containing boxes for flush work are made of white wood and for surface work of polished oak. Iron boxes are built of sheet metal plates, and when made for surface work have sides of enameled black. All of the standard style of tablet boards have two-wire branch circuits; but almost all of them can be furnished with three-wire branches if desired.

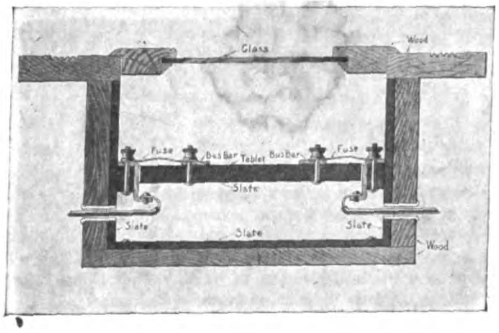


FIG. 36.—SECTION OF FLUSH BOX.

◆

NEW CENTRAL ENERGY TELEPHONE SWITCHBOARD.

The Western Electrical Supply Company of St. Louis has recently made a number of additions and improvements to its central energy telephone system, and is now furnishing switchboards of this type of from 50 drops up. The framework of the multiple switchboards is of substantial angle iron construction, and all angle irons and braces are held in place by bolts and machine screws. The wood work on the face and ends is of highly polished quarter sawed oak, thoroughly seasoned and carefully joined, and the general appearance of the board is very attractive.

The key shelf of each operator's position is hinged separately and is of the usual laminated construction to prevent warping. The visual signals are mounted in the upper panel above the multiple jacks, while the answering jacks are mounted in the lower panel, directly in front of the operator's position.

The removal of the receiver from the subscriber's telephone hook causes a visual signal to appear in view of the operator in the well-known manner, and at the same time lights a pilot lamp on the monitor's desk. These signals all remain lighted, of course, until the operator inserts the answering plug, when all lights are extinguished. A combination listening and ringing key is used. When the conversation is finished and the receivers are hung up, the clearing-out incandescent lamps light, showing that the conversation is ended, and the operator disconnects the line, as in other standard central energy systems. A simple and thoroughly reliable busy test is provided, which causes a click in the operator's receiver when a busy line is touched with a connecting plug.

This system, it is claimed, requires less wiring than the usual systems of its class, there being only three springs in the multiple jack, which reduces the wiring to three-fifths of that ordinarily required. The switchboard can be used with either local transmitter batteries or a central battery, without making any change in the wiring of the board; in both cases the subscriber's call is made by lifting the receiver from the hook. Additional sections may be added to multiple boards without cutting or splicing the multiple cables.

Another feature is that the spring jack has no compound contact. The insertion of a plug automatically shuts out the line signal instead of opening the circuit. When two parties are connected in this system, they have a straight connection through, without any relays, condensers, repeating coils or other apparatus in the circuit, and no ground connections are used whatever.

The insulation is entirely of pure, hard rubber. On account of there being only three jack springs instead of five, these can be placed three times the usual distance apart, which permits the use of the heaviest and most substantial insulation. The only wear to which the jack is subjected is that on the shell, and this is designed in such a manner as to allow it to be replaced with a new one with ease; it is not necessary to remove the entire strip from the board to repair one jack.

The construction is for full metallic circuit, and will operate equally well, it is said, on a common return or grounded circuit. The boards are made in any capacity for either lamp or visual signals.

◆

NEW BOOKS.

Wiring Tables. By Thos. G. Grier. (Second Edition.) Chicago: T. G. Grier. Flexible leather; 100 pages, 4 x 6½ ins.; 16 diagrams. Price, $1.

This edition of Mr. Grier's excellent little book has been somewhat improved by revision. The diagrams are elementary, illustrating the fundamental principles of the various systems of wiring, and the text relating to the laying-out of wiring is meagre. The tables, however, are comprehensive and very useful. The book still lacks adequate tables for alternating-current work.

The Universal (Berly's) Electrical Directory. London: H. Alabaster, Gatehouse & Co. Cloth; 1340 reading pages, 6 x 10 ins. Price, 10 shillings in Great Britain; 13 shillings in other countries.

This is the twenty-first annual edition of the well-known red-back directory, and maintains well the standard set by previous editions. It covers the electrical profession and industry in Great Britain, Europe, the United States and the British colonies. The United States section alone contains 5830 names; the total number is 28,900.

High-Speed Steam Engines. (Second Edition). By Wm. Norris and Ben H. Morgan. London: P. S. King & Son. Cloth; 206 + xiii pages, 5½ x 8½ ins.; 156 illustrations. Price, 10s. 6d. In the United States, $3.00.

The present edition of this book consists of the first edition supplemented by two sections devoted to the engines exhibited at the Paris Exposition in 1900 and the Glasgow Exhibition of last year. The section purporting to represent American practice still remains devoid of any reference to several of the principal American engines. The descriptions of the exhibits at Paris and Glasgow are very uneven in engineering value, some of them being entirely perfunctory and chiefly notable for the absence of desirable detail information, while others are very complete.

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PERSONAL.

MR. EDGAR H. BERRY has resigned his position as chief draftsman of the Equipment Department at the Brooklyn Navy Yard to accept a responsible position with the C. W. Hunt Company, West New Brighton, N. Y.

MR. O. G. SMITH has been appointed manager of the Philadelphia office of the Stillwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. Mr. Smith has been for the last two or three years on the staff of the air compressor department of the company.

MR. THOMAS D. WATSON, for several years prominently connected with the firm of J. Jones & Son, New York, has resigned his position there to take charge of the sales department of William Roche, manufacturer of the well known Standard dry battery and other specialties.

MR. EDWARD H. COX has resigned his position on the New York staff of the Electric Vehicle Company and connected himself with the Automobile Company of America. Mr. Cox is well known in the automobile field as a highly qualified expert in explosive engine work.

MR. LYMAN C. REED has been appointed representative of the Wagner Electric Manufacturing Company, St. Louis, Mo., at New Orleans, La. Mr. Reed succeeds his brother, Mr. Warren B. Reed, who has been appointed representative for the Wagner Company in Nicaragua and other Central American countries.

MR. U. N. BETHELL, general manager of the New York Telephone Company, has been admitted to practice in the United States Supreme Court. Mr. Bethell began the study of law while in government employ in Washington, D. C., and has already practised in the Supreme Court of the District of Columbia. He was presented for admission to the United States Supreme Court by Ex-Attorney General Griggs.

MR. G. H. ATKINS has resigned the position of general western agent for the Electric Vehicle Company to take the managership of the Chicago office of the Electric Storage Battery Company. Mr. Atkins is well known in western electrical circles, having been identified with the electric vehicle industry for some time past and with the General Electric Company's Chicago office prior to entering the automobile field.

MR. P. C. MORGANTHALER, who has been connected with the sales department of the Fort Wayne Electric Works for the past five years, during the latter part of which term he has been traveling salesman for the company in the state of Indiana, has resigned his position with the Fort Wayne company. Mr. Morganthaler's plans for the future are not entirely perfected, but he announces his intention to continue in the electrical industry.

MR. A. L. Mc CLURG, who for the past six years has been connected with the Harrison Safety Boiler Works, Philadelphia, Pa., has severed that connection to accept an important position on the staff of the Philadelphia office of the Stillwell-Bierce & Smith-Vaile Company. Mr. McClurg will co-operate with Mr. E. F. Austin, the Pittsburg representative of the company, in the feed-water heater and pump department.

◆

TRADE PUBLICATIONS.

SMALL MOTORS. General Electric Company—Catalogue No. 1037, executed in superb style and devoted to General Electric direct-current and alternating-current motors of 1-10 to 20 horse-power.

STEEL WIRE. Hammacher, Schlemmer & Co., New York.—A folder containing prices and other data of Felten & Guilleaume steel piano wire, which is applicable to a great many purposes in electrical work.

REVERSING MOTOR CONTROLLERS. The Electric Controller & Supply Company, Cleveland, Ohio.—Bulletin No. 3, devoted to this company's Type-U controller, which is a very compact form of reversing controller for electric motors.

FAN MOTORS. General Electric Company.—A highly ornamental catalogue descriptive of the 1902 styles of G. E. fan motor. These machines are built for all of the usual direct current and alternating current circuits and voltages.

TELPHERAGE INSTALLATIONS. United Telpherage Company, New York.—Circular No. 20, in which are illustrated a number of installations put in by this company, together with illustrations of different classes of work to which this ingenious system is applicable.

ENGINEERS' CHUMS. Mound Tool & Scraper Company, St. Louis, Mo.—This is a pocket-size pamphlet devoted to the Mound scraping tools for fitting valves, bearing brasses, etc.; cold chisels made from high-grade crucible steel, and packing tools for manipulating stuffing box packing.

DIRECT CONNECTED GENERATING SETS. Racine Hardware Co., Racine, Wis.—Bulletin No. 100, containing handsomely executed illustrations of Racine engines direct connected to various types of dynamos. These engines are of the vertical automatic type and are built in sizes from 2 horse-power to 37 horse-power.

STORAGE BATTERIES FOR VOLTAGE REGULATION. The Electric Storage Battery Company.—Bulletin No. 70, containing an exposition of the advantages of storage batteries used in connection with street railway systems and located out on the line in order to reduce the amount of copper required in the feeders.

STERLING CEILING FAN. Sterling Electric Motor Company, Dayton, Ohio.—An illustrated bulletin devoted to the Sterling direct current ceiling fan, which was described in our fan-motor article last month. The bulletin also contains important information concerning the company's methods of testing and guarantees.

BOILER COMPOUND. Standard Boiler Compound Company, Bradford, Pa.—A catalogue of sixteen pages devoted to the merits of Standard boiler compound and containing some strong testimonials from users of this material. The compound is put up in two forms, one for use in ordinary boilers, and the other for use in the boilers of steam automobiles.

TELEPHONE INSTRUMENTS AND APPARATUS. The Stromberg-Carlson Telephone Manufacturing Company, Chicago, Ill.—A handsomely executed catalogue of standard size, containing illustrations and descriptions of the well known Carlson telephone sets, individual parts, residence sets, intercommunicating sets, pocket outfits, switchboards, distributing racks, etc.

SAMSON TURBINES. Jas. Leffel & Co., Springfield, Ohio.—This is a well executed catalogue designated "Pamphlet K," and devoted to the latest types of Samson turbines. The catalogue gives all of the usual classes of information concerning this well known water wheel, together with illustrations of the various forms in which the wheel is built and several notable installations in which it is used.

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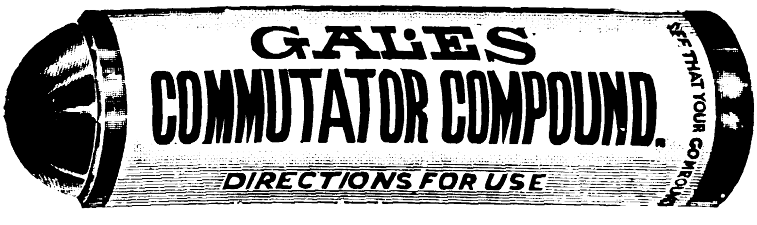

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ENCLOSED ARC LAMPS. National Arc Lamp Company, Lorain, Ohio.—This is a pocket-size pamphlet devoted to the enclosed arc lamp of this company, which is built for operation in multiple on alternating-current circuits. The lamp is designed to pass from 4½ to 5½ amperes, and the arc, therefore, can be lengthened to give a difference of potential from 85 to 90 volts, thus reducing the arc shadows beneath the lamp.

STILWELL HEATERS. The Stilwell Bierce & Smith-Vaile Company, Dayton, Ohio.—Catalogue No. 41, containing illustrated descriptions of the Stilwell heater and filter for exhaust steam, lime-extracting heaters, combined heaters and boiler feed pumps mounted on a single base, feed-water heaters, purifiers, and receiving tanks, closed heaters, etc. The catalogue also contains a large number of highly commendatory letters from users of these well known appliances.

CORLISS ENGINE. The Filer & Stowell Company, Milwaukee, Wis.—A handsome catalogue of standard size, containing illustrations and descriptions of the Filer & Stowell engines, together with some interesting views in the company's shops. Unlike many engine catalogues, this one contains illustrations of, and information concerning, actual constructional details of the engines. It also includes a large number of engravings showing installations of which these engines form a part.

WATER-SOFTENING APPARATUS. Industrial Water Company, New York.—An illustrated catalogue of water-softening and purifying apparatus, containing well chosen arguments concerning the advantages of such apparatus to steam plants. The catalogue also shows illustrations of water-softeners in use at several very prominent industrial establishments, among which might be mentioned those of the Henry R. Worthington Company, the Laidlaw-Dunn-Gordon Company, and the United Electric Company of Elizabeth, N. J.

TELEPHONE EQUIPMENT. Kellogg Switchboard & Supply Company, Chicago, Ill.—Bulletin No. 2, devoted to small switchboards, and Bulletin No. 7, devoted to transmitters, receivers, magnetos, and other parts of a subscriber's set. Bulletin No. 2 contains illustrations and descriptions of self-restoring combined drops and jacks, ringing and listening keys, clearing-out drops, and other parts of small switchboards, together with views of complete boards. Both catalogues are finely executed and cannot fail to be of much interest to telephone people.

RHEOSTATS. Union Electric Manufacturing Company, Milwaukee, Wis.—This is the first catalogue of the new company, and the present edition comprises a number of detachable sheets containing illustrations and descriptions of ordinary motor-starting boxes, an automatic starting switch for motors, adjustable regulators with underload release and with both underload and overload release, and a compact form of theater dimmer. All of the sliding-contact rheostats are provided with renewable contact pieces.

CORRESPONDENCE SCHOOL HANDBOOK. The American School of Correspondence, Boston, Mass.—This is the February number of the American School's Handbook, in which is described the plan of the school for enabling mechanics and others to improve their educational equipment without losing time from their everyday work. Several pages of the book contain illustrations of actual work done by students of the school, printed in two colors; the student's work being printed in black, and the instructor's corrections in red, thus giving an excellent idea of the method of teaching. The book also contains a number of commendatory letters from manufacturers, students and graduates of the school.

BUSINESS NEWS.

THE PERKINS ELECTRIC SWITCH MANUFACTURING COMPANY, formerly of Hartford, Conn., has removed its principal office and factory to Bridgeport, Conn., the local address in that city being No. 1421 State Street.

THE CUTTER COMPANY has removed its New York office from 120 Liberty Street to 15 Cortlandt Street. The office continues under the capable management of G. A. Annable, who is well and favorably known throughout the electrical trade.

STANDARD UNDERGROUND CABLE COMPANY has removed its Boston office from Tremont Building to 101 Milk Street. This move was necessary in order to obtain larger quarters which would be adequate for the handling of the increased business of the New England district.

THE H. W. JOHNS-MANVILLE COMPANY, New York, reports a large increase in its already heavy business in heat-insulating materials. Heavy contracts have been taken recently for fire-belt covering, asbestos sponge molded covering, and asbestos cell coverings for steam pipes, fittings, etc.

SPON & CHAMBERLAIN, the well known publishers and importers of engineering books, have removed from their old headquarters at 12 Cortlandt street, where they have been for the past fifteen years, and taken more commodious offices in the Liberty Building, 128 Liberty Street, New York.

AUTOMATIC TELEPHONE INSTALLATIONS.—Among the recent contracts closed by the Clark Automatic Telephone Switchboard Company, Providence, R. I., for automatic telephone systems are the following: Maine Insane Hospital, Augusta, Me., a 60-station equipment; De Beers Explosive Works, Cape Town, South Africa, a 48-station equipment.

ROSIN SOLDER is a new material which has recently been put on the market by the Kellogg Switchboard & Supply Company, Chicago. This material is made in the form of flattened wire and is wound on spools for convenience in handling and transportation. The advantages of rosin solder are that no acid whatever is used in its manufacture or is necessary in its application.

THE TRIUMPH ELECTRIC COMPANY, of Cincinnati, has found it necessary on account of the large increase in its eastern business to open a New York office at 39 Cortlandt Street. The office is in charge of Mr. J. P. Burckhardt, who has for the past several years been connected with the main office of the Triumph Company at Cincinnati. He is thoroughly acquainted with Triumph apparatus and has had a long and varied experience in the electrical field.

GOING TO THE ELECTRIC LIGHT CONVENTION.—Delegates from western cities to the Electric Light Convention, which will be held in Cincinnati next month, will be inerested to know that the Monon Route and C. H. & D. Railway run four daily trains between Chicago and Cincinnati. These trains leave Chicago at convenient hours and afford the highest class of service. Rates and other details may be obtained from the company's local office at 232 Clark Street, Chicago, Ill.

THE LIBERTY MANUFACTURING COMPANY, Pittsburg, reports the following recent sales of the well known "Famous" oil filter and refiner: Iron River Light & Power Company, Iron River, Wis.; Municipal Water & Light Department, North Vernon, Ind., and the Cannonsburg Electric Light, Heat & Power Company, Cannonsburg, Pa. Besides these, large numbers of filters have been sold to industrial establishments outside of the electrical class.

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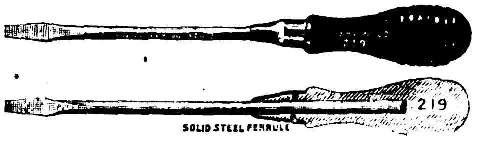

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unknown. The company states that its various types of dry batteries have been adopted by many prominent gasoline engine and automobile manufacturers for engine ignition, and believes that an acceptance of the above-mentioned offer will convince telephone manufacturers of the merits of the type of battery concerned.

UNITED STATES CARBON COMPANY, Cleveland, Ohio, has been reorganized and is under a different management. A good many changes have been made also in factory methods. A long series of experiments has enabled the company to turn out a carbon for open arc work for which extremely strong claims are made. Experiments are now in progress on high grade carbons for enclosed arc lighting, and the company expects by April 15 to produce a superior article of this kind.

FRANCE METALLIC PACKING, after a severe competitive test, has been adopted by the Metropolitan Street Railway Company, New York, for its eleven 7000-h. p. engines; the New York Gas & Electric Company for its eight 7500-h. p. engines; Brooklyn Edison Company for two 7000-h. p. engines; Boston Elevated R. R. for two 7000-h. p. engines, and the New York Central & Hudson River Railroad for stationary work. It is also used in equipping the Manhattan Elevated Railway engines in the large new power house. This packing is made by A. W. France, Tacony, Philadelphia.

THE FULLMAN COMPANY is the style of a new organization in which are consolidated the Vulcanite Manufacturing Company, Ltd., and the Fullman Company, Pittsburg, Pa. The new company will continue the business of contract electrical engineering in which each of the component companies was previously engaged. Among notable pieces of work done by the old Fullman Company was the electrical equipment of the new Union Station and twelve story office building of the Pennsylvania Railroad Company at Pittsburg, in which work there were required about 50 miles of electric ducts, and an aggregate capacity of 1800 miles of telegraph, telephone, electric signaling, and motor wiring.

THE MICA INSULATOR COMPANY, of New York, is now supplying its well known Empire oiled cloths and papers in rolls of 50, 100 and 500 yards length, as well as rolls of any special length desired. It is stated that an entirely new and original process enables the manufacturers to coat the material with two very evenly distributed coats of pure linseed oil, and it is claimed that experience has proven pure linseed oil refined and treated by the company's process to be superior as a coating for cloths and papers to any substitutes. Empire cloth is said to retain its high finish and flexibility indefinitely, so that it may be kept in stock a long time without mechanical or electrical deterioration. It is thoroughly dried before leaving the factory, and does not need any wax paper between the sheets to prevent them from sticking together.

THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, of Chicago, has been making arrangements recently whereby the capital stock of $50,000 will be increased to over $2,000,000. The money so raised will go into an increase of manufacturing facilities. In spite of the marvelous growth of this concern, from the employment of 5 men in 1895, to 1000 men, occupying all of a seven-story building, covering a quarter of a large city block, in 1901, the capital stock has not heretofore been increased beyond the original issue of $50,000. Thomas W. Finucane and Eugene H. Satterlee, of Rochester, N. Y., are among the important additions to the financial strength of the company. The officers and management remain the same as before: Alfred Stromberg, president; Androv Carlson, vice-president; A. B. Cotton, secretary, and J. W. Johnston, treasurer. These, with Chas. A. Brown, the well known patent attorney, constitute the board of directors.

THE HAINES & NOYES COMPANY, Chicago, has closed the following contracts during the past month: Hotel Freemont, California, a 130-drop switchboard and 130 telephones; Conservative Life Building, Los Angeles, Cal., a 90-drop switchboard and 90 telephones; a large apartment building in Evanston, Ill., a 35-station telephone system; the new high school, Chicago, a 25-drop switchboard and 25 telephones; Marsh & Uhlmann, Chicago, an intercommunicating system using 17 hand microtelephones. Through its agents in Los Angeles, Cal., the Woodill & Hulse Electric Co., twenty inter-communicating systems have been installed in Los Angeles and surrounding territory. Through the John M. Klein Electric Co., San Francisco, a 36-telephone system has been sold to the U. S. Government for the Puget Sound Navy Yard. The home office of the company has sold 10 apartment telephone systems in Chicago, and is equipping the St. Anthony's Hospital and the J. S. Ford-Johnson Chair Factory, Michigan City, Ind.

RONEY STOKERS.—A list of recent installations of Roney mechanical stokers, which has just been compiled by Westinghouse, Church, Kerr & Co., includes some famous steam plants and shows that an aggregate of about half a million horse-power of boilers have been equipped with the Roney apparatus. The list starts with the four large organizations upon which New York City depends for its lighting and transportation service, namely, New York Edison Company, Metropolitan Railway Company, Third Avenue Railway Company (now controlled by the Metropolitan) and the Manhattan Railway Company. These plants aggregate 128,500 horse-power of boiler capacity, fitted with Roney mechanical stokers. Lighting, street railway and industrial concerns throughout the country, swell the aggregate to a round half-million horse-power. The list is representative of power using industries, and includes central station and isolated electric lighting plants, street railway power houses, steam railroad shops and terminal stations, refineries, chemical works, cotton, woolen and silk mills, mining, smelting and refining plants, paper and flour mills and large manufacturing companies of every description.

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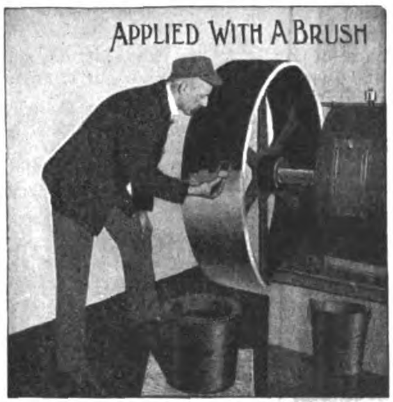

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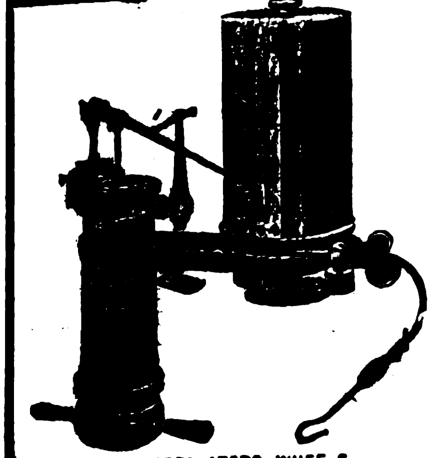

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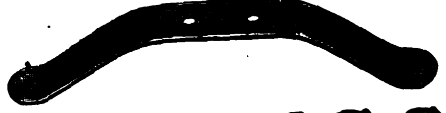

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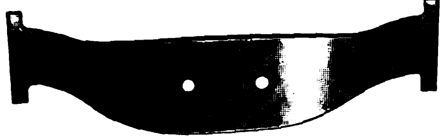

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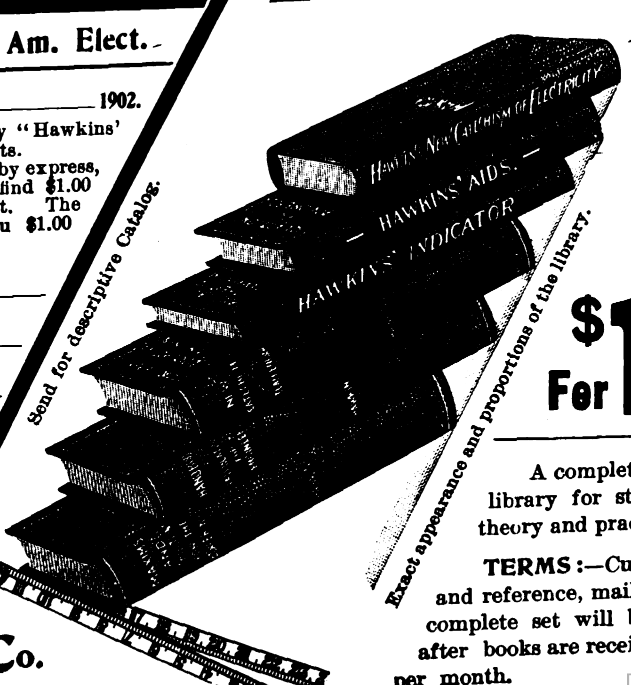
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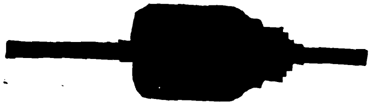

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Vol. XIV. New York, May, 1902. No. 5.

POWER GENERATING EQUIPMENT OF A SPICE FACTORY.

PLANT OF THE STICKNEY & POOR SPICE COMPANY, AT CHARLESTOWN, MASS.

An interesting example of the application of electricity to the needs of a small industrial establishment is afforded by the electrical equipment of the Stickney & Poor Spice Company's factory at Charlestown, Mass. All of the grinding mills are driven by motors, and the factory is electrically lighted; current for both classes of service is supplied by a generating plant on the premises.

The boiler room equipment at present comprises two return-tubular boilers, built by Edward Kendall, of Cambridge, Mass. These are 72 ins. and 66 ins. in diameter by 18 ft. and 16 ft. long, respectively, and contain one hundred 3½-in. tubes and one hundred and twenty 3-in. tubes, respectively. The fuel used is a half-and-half mixture of Cumberland and hard coal screenings, and the working steam pressure is 80 lbs. The boilers feed, by means of a 5-in. and a 6-in. main, into an 18-in. header, or drum, which supplies a 12-in. main for the engine, a 1¼-in. main for the pump and the injector, and a 3-in. main for the mill. The header, or drum, is provided with a 1-in. drain, which is carried through the shell of the larger boiler to a point a few inches below the water line. The boilers blow off through 2-in. pipes into a 4-in. blow-off main leading to a blow-off tank.

The floor of the engine room is above the level of the floor of the boiler room, and the engine is "under fed"; consequently, the steam main supplying the engine descends in two sweeps in vertical planes at right angles to each other, as shown in Fig. 2, and empties into a 36-in. steam reservoir, 7½ ft. high, situated in the basement beneath the engine room. The feed water is supplied through 1½-in. feed pipes from either a Deane (Holyoke) duplex pump or an injector. When fed by the pump, the water passes through an American feed-water heater. Both the pump and the injector are connected with the city water supply, and also a 70,000-gal. tank containing all the rainwater which falls on the plant, and they are so piped that either can be used with either source of supply, the pump having an automatic regulator, actuated by the height of the water in the boilers. Both the pump and the injector are provided with 1-in. drains, and are also connected by a 2½-in. suction pipe with the tank.

As will be seen from Fig. 8, all of the steam and water piping is located in the basement beneath the engine room. The exhaust steam from the engine and pump passes through the American feed-water heater, and either out through a 10-in. back-pressure valve and a 10-in. exhaust pipe to the atmosphere, or to the heating system, according to the requirements of the latter. Though incomplete at the present time, this system will be ar-

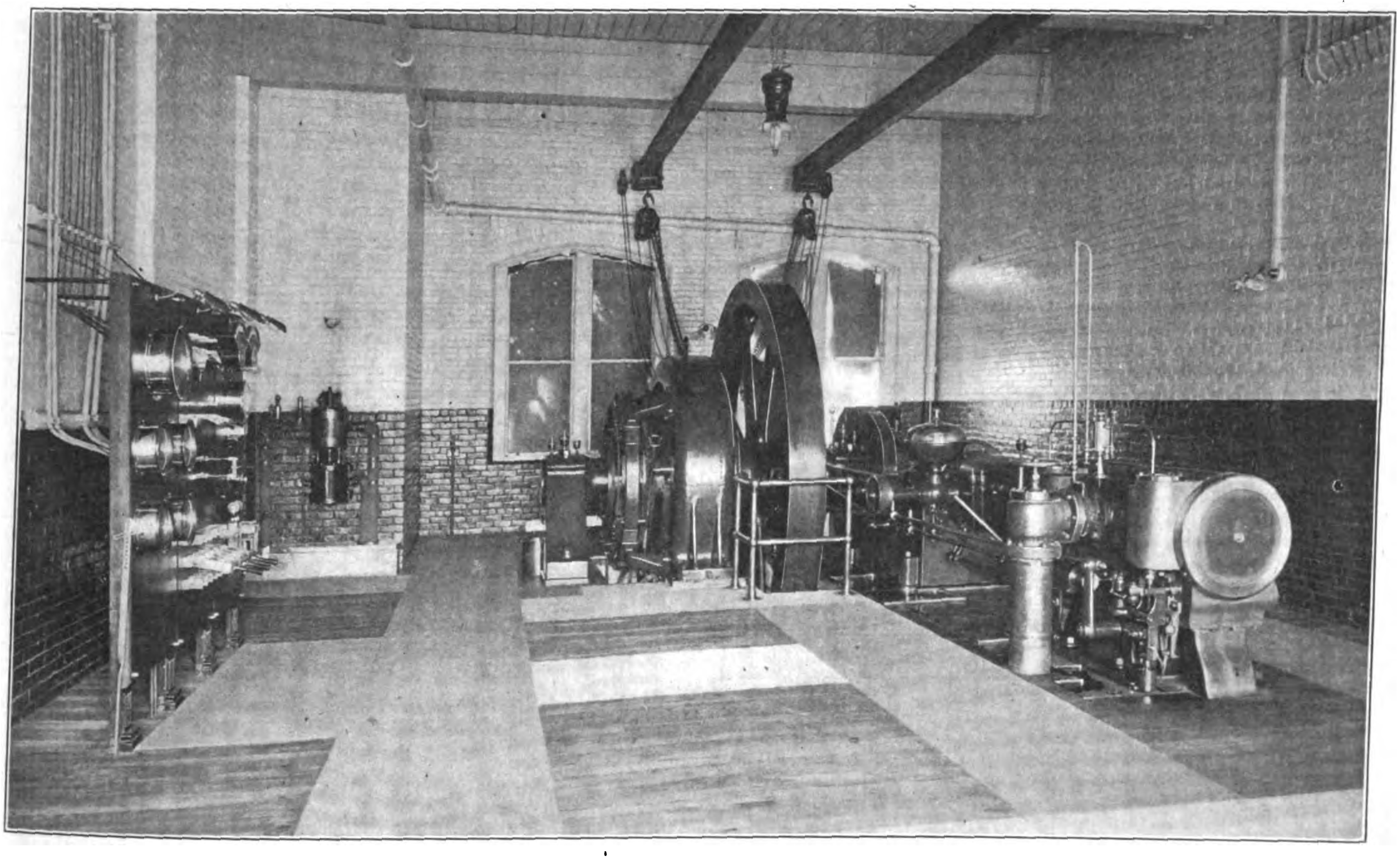


FIG. 1.—VIEW IN THE ENGINE ROOM OF THE PLANT.

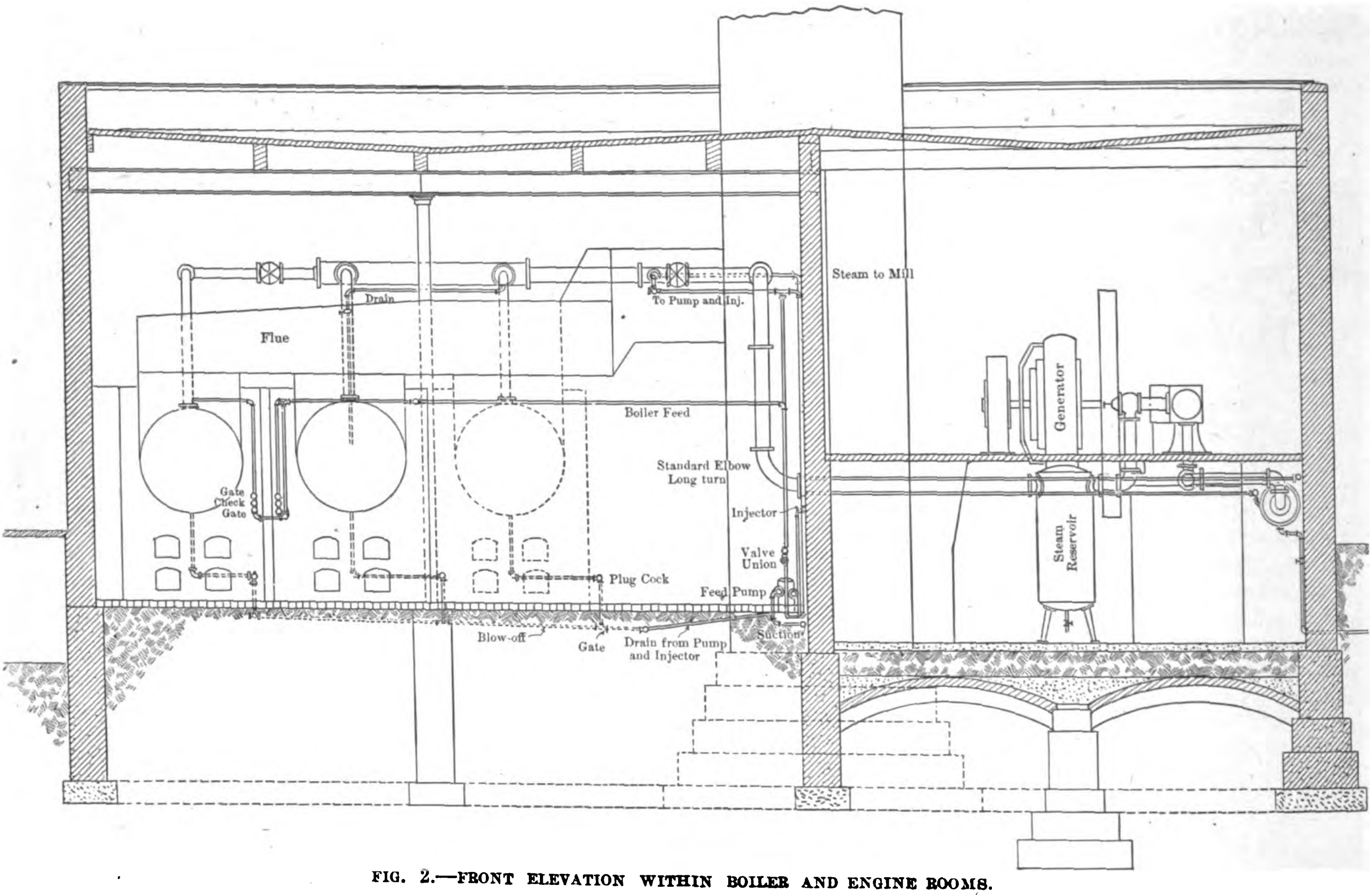

Steam to Mill
Drain
To Pump and Inj.
Flue
Boiler Feed
Standard Elbow
Long turn
Injector
Gate
Check
Gate
Valve
Union
Plug Cock
Feed Pump
Suction
Blow-off
Gate
Drain from Pump
and Injector
Generator
Steam
Reservoir

FIG. 2.—FRONT ELEVATION WITHIN BOILER AND ENGINE ROOMS.

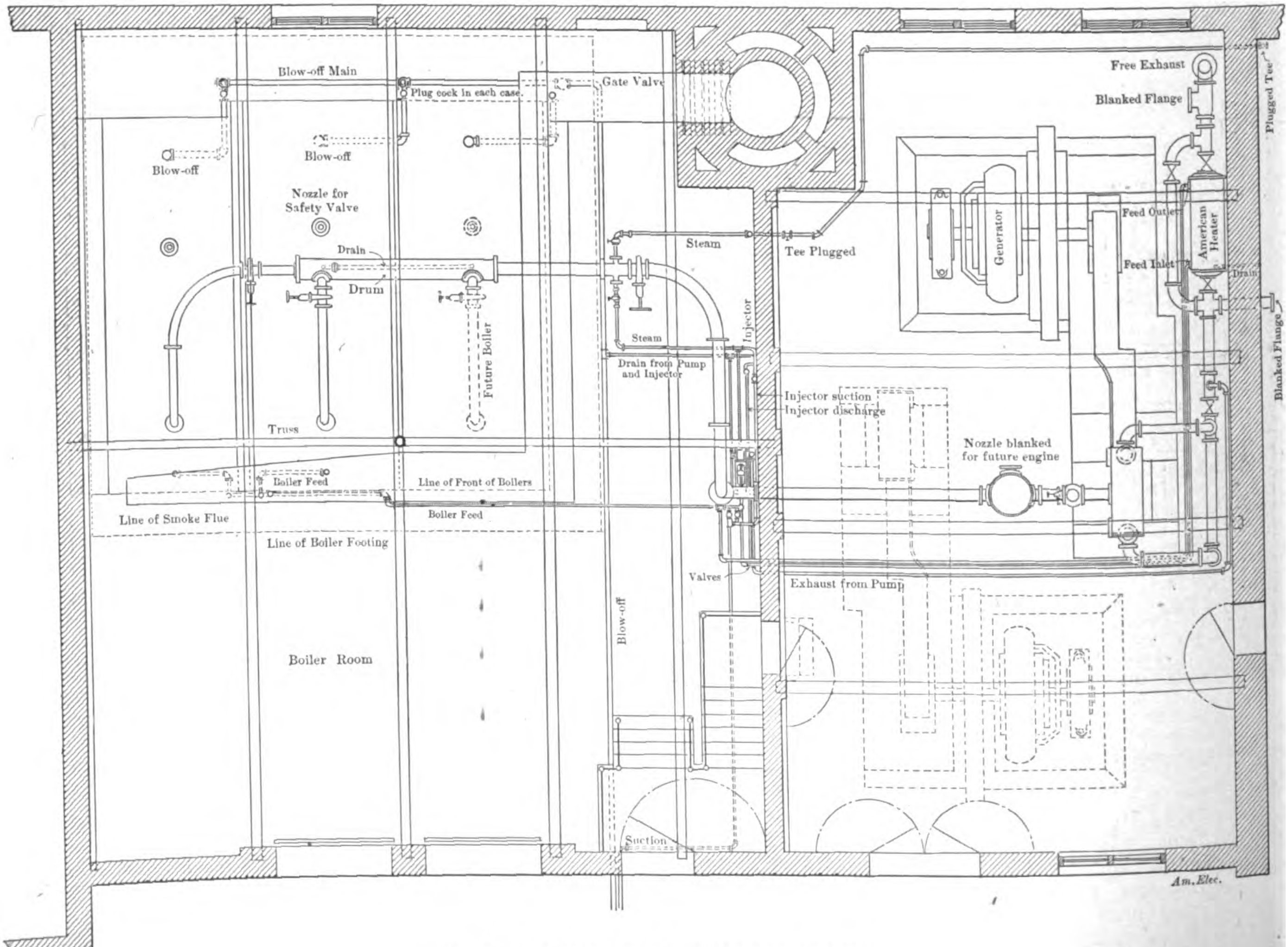

Blow-off Main
Plug cock in each case.
Gate Valve
Blow-off
Blow-off
Nozzle for
Safety Valve
Drain
Drum
Future Boiler
Steam
Tee Plugged
Steam
Injector
Drain from Pump
and Injector
Injector suction
Injector discharge
Truss
Boiler Feed
Line of Front of Boilers
Line of Smoke Flue
Boiler Feed
Line of Boiler Footing
Nozzle blanked
for future engine
Valves
Exhaust from Pump
Blow-off
Boiler Room
Suction
Free Exhaust
Blanked Flange
Plugged Tee
Generator
Feed Outlet
American
Heater
Feed Inlet
Drain
Blanked Flange
Am. Elec.

FIG. 3.—PLAN VIEW OF BOILER AND ENGINE ROOM.

ranged ultimately so that all of the drips will be returned to the boiler through an oil separator. A by-pass is provided for the feed-water heater, so that should occasion require it may be cut out while the plant is in operation without interfering with the working of the plant. All of the other steam and water piping is shown in the engravings. Space is provided in the boiler room for additional equipment, as indicated by the dotted outlines in Fig. 2.

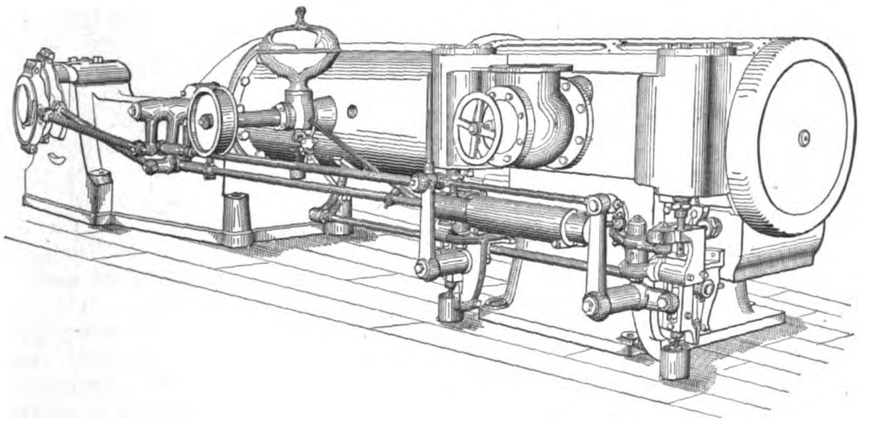


FIG. 4.—VIEW OF BROWN ENGINE, SHOWING VALVE GEAR.

The engine room contains an 18-in. by 36-in. simple non-condensing engine, direct-connected to a 125-kw. generator, and also a 9½-in. Westinghouse locomotive air pump, which supplies air at 60 lbs. pressure to a compressed air system for cleaning the machines throughout the factory. The engine was built by C. H. Brown & Co., of Fitchburg, Mass., and is provided with their heavy-duty tangye frame, and has a fly-wheel 12 ft. in diameter and a 12-in. face. It is of the Brown standard four-valve releasing-gear type, with gridiron admission and exhaust valves operated by separate eccentrics, as shown by Fig. 4. The admission valves work on vertical seats, while the exhaust valves are placed horizontally immediately below the bore of the cylinder, and both valves are fitted with removable seats.

The valve-gear forms a distinctive feature of the engine. The valves are held in bored recesses provided for them in the body of the cylinder, and are located very close to the bore, in order to reduce the clearance as far as practicable. Fig. 5 shows a section through the valves and valve-gear looking from the governor toward the cylinder head, from which a better understanding of the operation of the valves may be had. As may be inferred from their short motion, the steam valves are opened very quickly, giving a full port opening very early in the stroke, and, as shown in the indicator diagrams herewith, maintaining a straight steam line with but very slight fall in pressure from that at the throttle. The admission valves are connected to bell cranks operated by the eccentric rod, as shown in the engraving. The valve is lifted until it is tripped by the action of the governor, when it closes very quickly under the action of gravity, assisted by the unbalanced part of the steam pressure on the head of the valve stem. No springs or vacuum pots are provided, and the cut-off is very sharp; an air dash-pot cushions the down stroke.

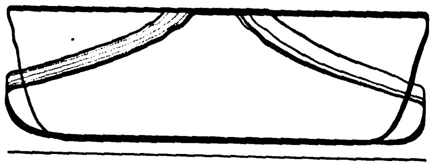


FIG. 6.—INDICATOR DIAGRAMS FROM BROWN ENGINE.

The exhaust valves are connected to a sliding bar shown on the front of the cylinder, through links and bell-cranks on vertical axes which cause the valves to slide across the bore of the cylinder in response to the reciprocating motion of the bar. The effect of the bell-crank angle is to open the valves quickly at the beginning of the exhaust and hold them fully open until the stroke is nearly com-

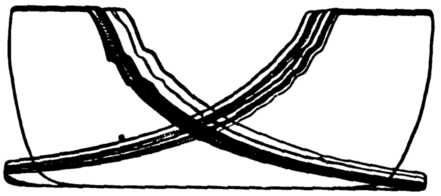
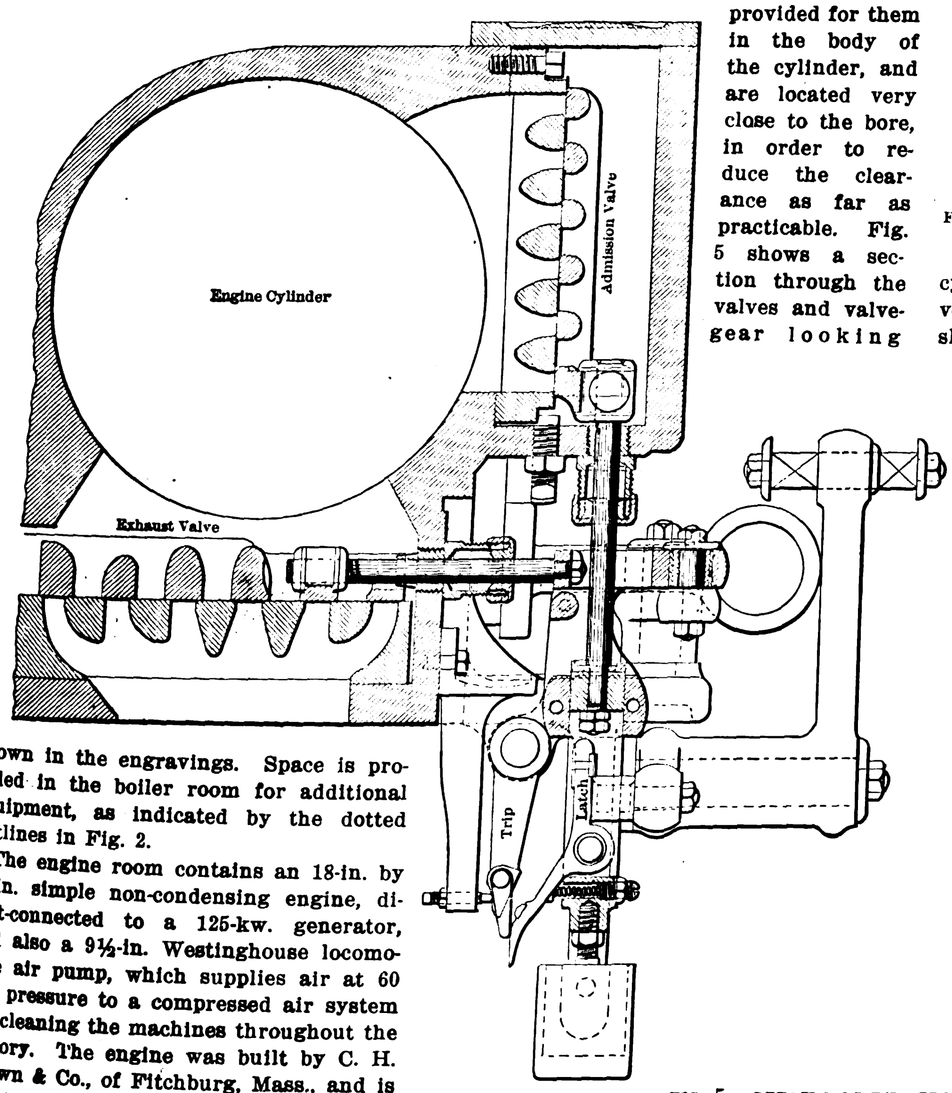


FIG. 7.—INDICATOR DIAGRAMS FROM BROWN ENGINE.



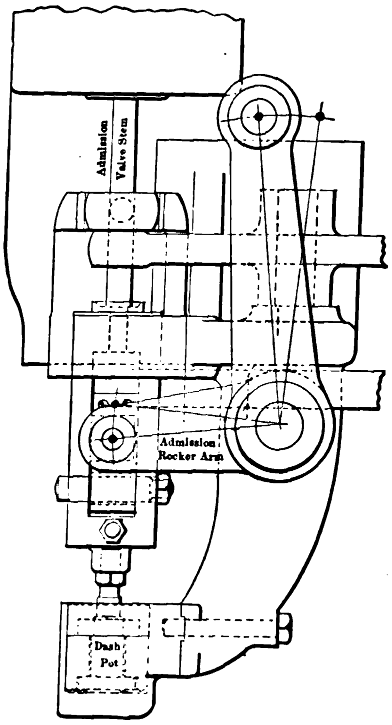


FIG. 5.—DETAILS OF THE BROWN VALVE GEAR.

pleted, only closing them in time to provide the necessary compression. This not only gives a free exhaust, but also provides means for quickly freeing the cylinder of any water which may enter. The exhaust being located at the bottom of the cylinder, and being provided with large ports and an exhaust pipe leading straight down as shown, the water is permitted to run out freely.

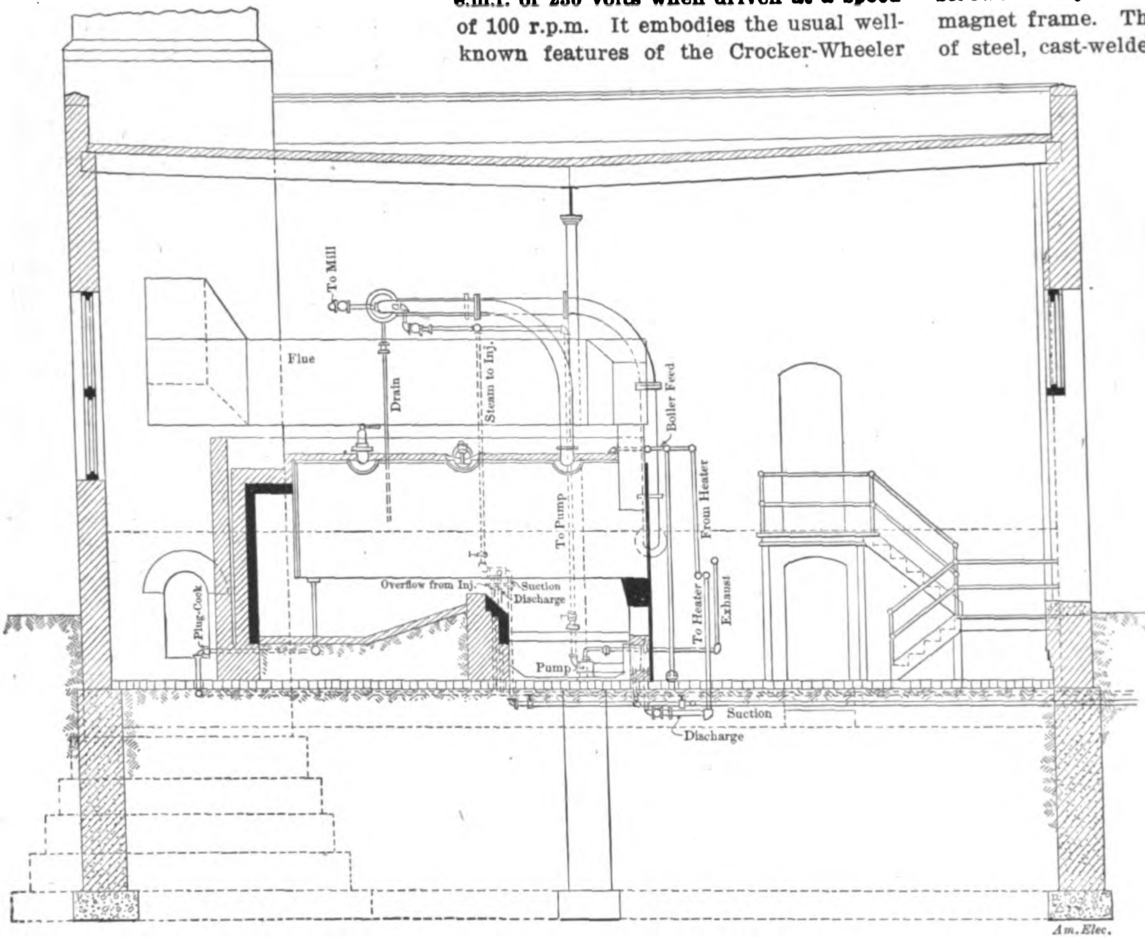


FIG. 6.—SIDE ELEVATION WITHIN BOILER ROOM.

The governor is belt driven and of very simple construction. It is protected from dust by a casing, as shown in Figs. 1 and 4; adjusting screws for regulating the movement of the governor weights, and consequently the speed of the engine, are located beneath the cover of the governor casing. The degree of cushioning afforded the steam valves by the dash-pots is regulated by means of a knurled-head tapered pin located near the bottom of the cylinder.

Figs. 6 and 7 were reproduced directly from steam indicator cards taken from this engine and referred to above. These show the results obtained by the use of the gridiron type of valve in the sharpness of the cut-off, and the straightness of the steam and admission lines, and incidentally show the value of using separate eccentrics for the admission and exhaust valves when operating on a rapidly-varying load. Space has been left in the engine room for another direct-connected set, as indicated by the dotted outlines in Fig. 3.

The generator is a Crocker-Wheeler machine of 125 kilowatts capacity; it is compound-wound and gives a terminal e.m.f. of 230 volts when driven at a speed of 100 r.p.m. It embodies the usual well-known features of the Crocker-Wheeler engine-type generators. The magnet frame is a cast-iron ring of patented girder construction, divided horizontally. The lower half of the frame is provided with feet, drilled to receive the holding-down bolts, and is equipped with leveling screws to adjust the position of the field-magnet frame. The poles are round and of steel, cast-welded into the frame, and each is fitted with a removable shoe. To guard against mechanical injury, the field coils are wrapped with a protective covering. The armature is of the conventional iron-clad type; the toothed core laminations of mild steel are held to the spider by a large number of dovetail tongues and grooves machined to a close fit.

The cast-iron brush-holder ring is supported in guides on four brackets bolted to the frame, and is capable of the usual adjustment; the brush holders are supported on studs bolted to the ring. The brush rigging is so constructed that individual adjustment of the brackets carrying the brush holders can be made; this is a patented feature of the Crocker-Wheeler machines, making it possible to balance the electrical circuits and thereby mitigate sparking and wear at the brushes. The brush holders are of the

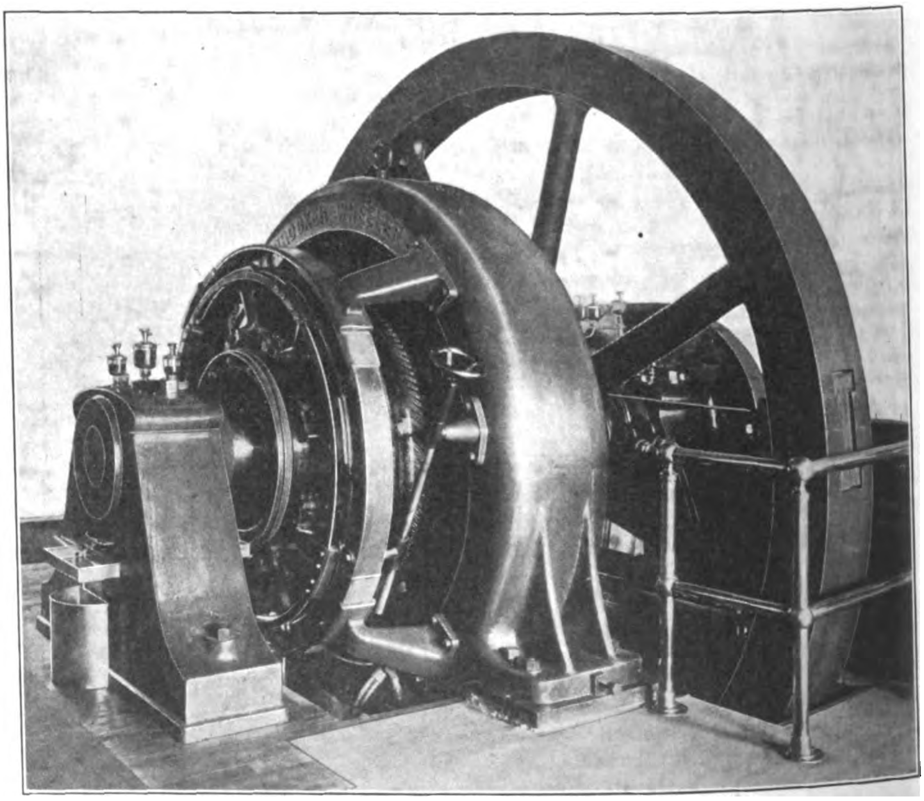


FIG. 7.—NEARER VIEW OF DIRECT CONNECTED GENERATOR.

Crocker-Wheeler parallel type, amply proportioned, and have no sliding contacts.

The engine room is fitted with two 6000-lb. geared traveling cranes, working on parallel beams over the engine and generator respectively, which may be used independently or together.

As shown in Fig. 1, the switchboard has three panels: a generator panel, a distribution panel, and a gauge panel. The first has the usual ground detectors, circuit-breakers, etc., besides an ammeter, voltmeter and recording wattmeter. The distribution panel contains three double-throw power switches and six single-throw switches, controlling as many circuits for lighting purposes. In addition, the lighting system is controlled by a double-throw switch, one pair of studs being connected to the generator, and the other pair to the electric mains supplying the city. The power circuits supply motors in the mustard department, spice department and general-service machines. By means of double-throw switches in connection with the motors, it is possible to get a written record of the power used on each machine or any group of machines. These are filed away for reference, together with the amount of coal and water used per day. These records are useful in determining the cost of grinding the different kinds of goods. The gauge panel contains a clock, steam gauge, back pressure gauge, air gauge and revolution counter.

The motor equipment was installed by the Westinghouse Electric & Manufacturing Company. It consists of one 40-h.p. motor, belted to a line shaft in the mustard department; one 30-h.p. ceiling motor belted to a line shaft in the French mustard department; two 20-h.p. and one 15-h.p. ceiling motors belted to a countershaft from which spice mills are driven; two 30-h.p. direct-connected motors; one 30-h.p. motor, belted to a line shaft in the bolting department; and one 5-h.p. motor used for driving conveying machinery.

The entire plant is highly creditable to those who were responsible for its design and installation. The engineering work was done under the supervision of Mr. W. L. Church, of Lockwood, Greene & Co., and Mr. John B. Fallon, Jr., superintendent for the Stickney & Poor Spice Company, to whom we are indebted for much of the information here presented.

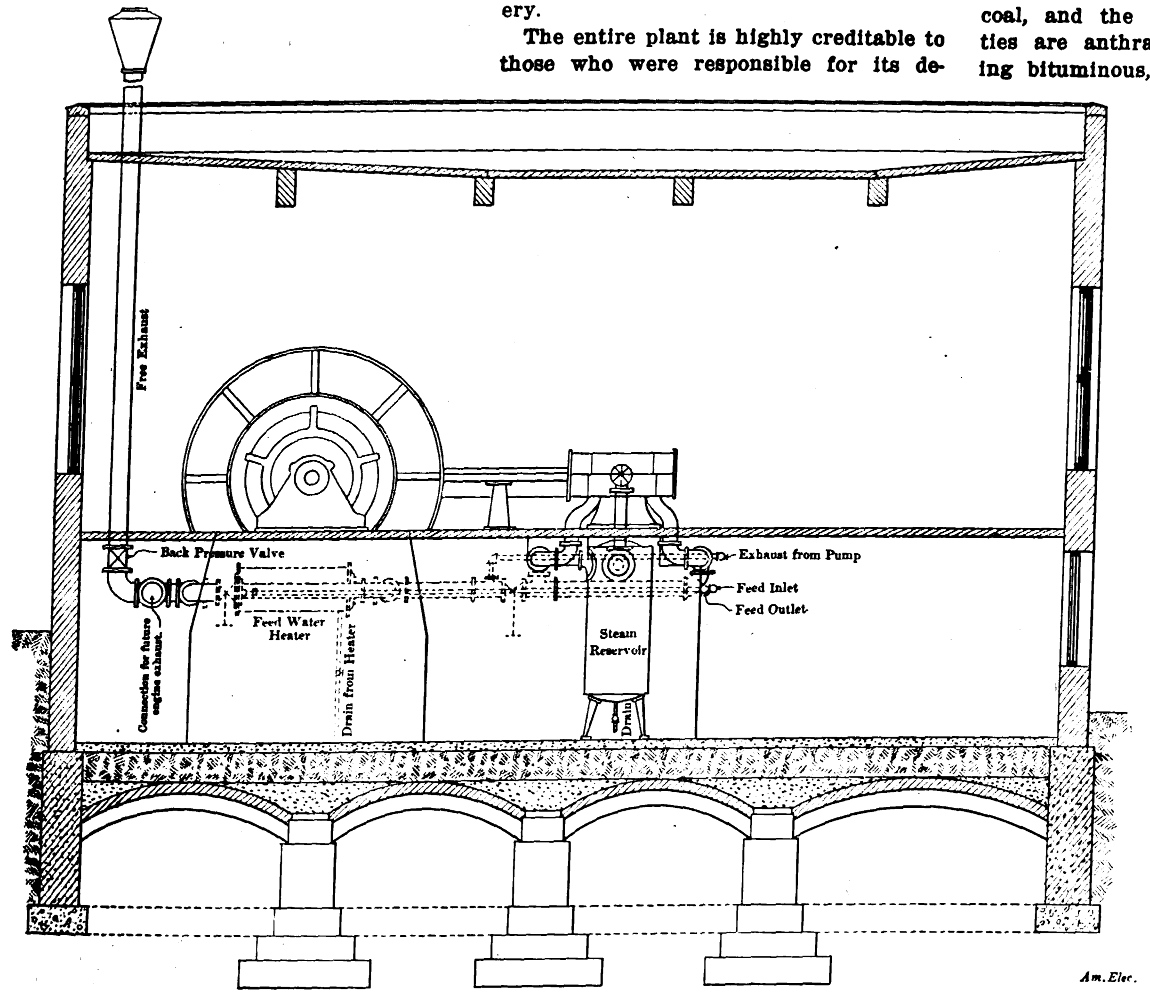


FIG. 8.—SIDE ELEVATION OF ENGINE ROOM.

◆

Coal vs. Wood.—Engineers who have had opportunities for comparing the value of pine and coal, seem to agree upon the ratio of 2½ to 1 as representing the average. In this case 2½ lbs. of wood are equivalent to a pound of coal; and, therefore, the weight of wood which must be burned on each square foot of grate surface will equal 2½ times the weight of coal required, in order to obtain the amount of heat which would be realized from burning the latter kind of fuel.

FUELS.

BY H. C. LINCOLN.

Coal is the most important fuel, of course, and in many localities the only one. In some places wood, gas and oil are abundant and therefore take the place of coal, and in certain manufacturing plants the waste products, such as straw, tan, sawdust and bagasse, are available in sufficient quantity and therefore serve as fuel more economically than coal. But considered generally, the chief fuel is coal, and the five most important varieties are anthracite, dry bituminous, caking bituminous, cannel and lignite.

Anthracite coal is a hard variety and consists almost entirely of carbon, having but a small percentage of hydrocarbon. The best quality is hard and lustrous and breaks up easily at a high temperature. It burns with very little flame and smoke, unless wet, and gives an intense heat. In order to get the best results with this coal a grate with small air spaces should be used. Owing to the brittleness of the coal, part of it is broken into fine pieces, which would be lost if coarse grates were employed. There is a variety of coal called semi-anthracite or semi-bituminous, which contains more hydrocarbon; this is not so hard as anthracite proper, and burns with a short flame. Anthracite coals are found chiefly in the Alleghany Mountains and in the Colorado section of the Rocky Mountains.

Bituminous coal contains from 70 to 80 per cent of carbon and a large amount of hydrocarbon. Dry bituminous coal burns freely, with little smoke and without caking. This variety is found in Maryland and Virginia. Caking bituminous coal becomes pasty, swells and cakes when burning. It is used largely for making illuminating gas and is found principally in the Mississippi Valley. Caking coal contains from 50 to 60 per cent of carbon.

Cannel coal, sometimes called long-flaming bituminous, has a tendency to smoke, and some varieties cake when heated. It contains from 70 to 85 per cent of carbon, and is mined in Pennsylvania, Indiana and Missouri.

Lignite or brown coal is intermediate between peat and coal. It contains from 55 to 75 per cent of carbon, with some moisture and mineral matter. The poorer varieties have a low value as fuel. Lignite is found in Colorado, Texas and Washington.

Coke is produced by driving off the hydrocarbon of bituminous or semi-bituminous coals by means of heat. When made in gas retorts it has a low value as a fuel. When it is made in coking ovens it is dark gray, hard, porous and brittle. Coke burns without flame and will, if forced, make a hot fire.

Charcoal is rarely used for steaming purposes. It is made by evaporating the volatile constituents of wood, either by partial combustion or by heating in retorts. In the former method the wood is piled in conical heaps and covered with earth and "burned" by admitting a very small quantity of air which allows only partial combustion to take place. By this method 100 pounds of wood will produce about 20 pounds of charcoal. If made in a retort it produces about 30 pounds. A cord of wood commonly yields about 50 bushels of charcoal.

Peat, or turf, consists of decayed roots and earthy matter. It is found in bogs and swamps, from which it is cut; it is then dried, and is sometimes pulverized and compressed into briquettes to be sold as an artificial fuel. The amount of ash varies from 5 to 11 per cent.

Wood, when considered as a fuel, is divided into two classes, known as hard and soft. The heating value for a given weight is very nearly the same for different kinds; that is, one pound of hickory or maple is worth no more as fuel than one pound of pine. Wood contains considerable moisture even when kept for a long time in a dry place; after being thoroughly dried it will absorb from 10 to 20 per cent of moisture. The chemical composition of different woods is nearly the same, and is shown approximately in Table I.

TABLE I.

Average Composition of Fuel Woods.

	Perfectly dry wood.	Ordinary fire wood.
Carbon	50 p.c.	37.5 p.c.
Hydrogen	6 p.c.	4.5 p.c.
Oxygen	41 p.c.	30.75 p.c.
Nitrogen	1 p.c.	.75 p.c.
Ash	2 p.c.	1.5 p.c.
Moisture	.....	25.0 p.c.

Wood that is kiln-dried has a theoretical heat value of about 8000 heat units (B.T.U.) per pound, so that wood containing 25 per cent of moisture has a value of only about 6000 B.T.U. per gross pound.

The most important elements in coal are hydrogen, which produces 62,000 heat units per pound, and carbon, which produces 14,500, when burned. Although several coals may have the same total percentage of combustible and ash, the heat values may not be the same; because the heat value depends upon the amounts of hydrogen and carbon contained. The value of any fuel is determined by chemical analysis or by calorimetric test, and differs in coals from different localities. Table II gives the heat units per pound for the perfect combustion of different kinds of coal; also the theoretical evaporation of water per pound—that is, the evaporation that would be obtained if all of the heat given off were delivered to the water by the boiler.

TABLE II.

Heat Values of Different Varieties of Coal.

Kind of Coal.	Per cent of ash.	Theoretical heat units per pound.	Theoretical evaporation of water in pounds, per pound of coal.
Penn. Anthracite	3.49	14,199	14.70
Penn. Anthracite	2.90	14,221	14.72
Penn. Cannel	15.02	13,143	13.60
Penn. Connellsville	6.50	13,368	13.84
Penn. Semi-Bitum's	10.77	13,155	13.62
Penn. Brown	9.50	12,324	12.75
Kentucky Caking	2.75	14,391	14.89
Kentucky Cannel	2.00	15,198	16.76
Kentucky Lignite	7.00	9,326	9.65
Indiana Caking	5.66	14,146	14.64
Indiana Cannel	6.00	13,097	13.56
Maryland Cumberland	13.98	12,226	12.65
Arkansas Lignite	5.00	9,215	9.54
Colorado Lignite	9.25	13,562	14.04
Texas Lignite	4.50	12,962	13.41
Washington Lignite	3.40	11,551	11.96
Pocahontas	4.7	14,100	14.61
New River	4.6	13,900	14.40

In practice the theoretical evaporation is never obtained, owing to various losses of heat from the boiler and furnace. It is radiated from and conducted away by the boiler setting; and the admission of air into the furnace, either through the doors or through cracks in the setting, reduces the evaporation. Other losses are caused by improper firing and errors in boiler design, construction and setting. A boiler seldom gives an efficiency of 80 per cent, and the average is from 65 to 70 per cent. This would give about 9800 heat units as utilized by the average boiler from a pound of the best anthracite coal, or an evaporation of about 10 pounds of water per pound of coal.

Tan or bark, after it has been used in the process of tanning, is sometimes dried and burned in the boiler furnace. The heating value of dry tan containing 15 per cent of ash is about 6000 heat units per pound. If the tan is in the ordinary state of dryness, containing from 25 to 30 per cent of moisture, the heat value drops to about 4300. Perfectly dry tan will evaporate 6.3 pounds of water from and at 212°. If the tan contains 30 per cent of moisture it will evaporate only 4.4 pounds, approximately.

A pound of straw contains about 8000 heat units and is capable of evaporating 7.3 pounds of water under the above conditions. Bagasse is the fibrous portion of sugar cane left after the juice has been abstracted. It usually contains from 25 to 40 per cent of moisture and must therefore be dried before it is used as fuel. Bagasse is ordinarily equal to about 1-5 of its weight of coal. The more thoroughly the juice is extracted the drier will be the refuse and the greater its evaporative power. Bagasse should be fed continuously into a very hot fire-brick chamber which gives plenty of room for the large volume of gas and steam produced by evaporation. In some instances bagasse is burned without drying in special furnaces designed for the purpose.

Petroleum is a hydrocarbon liquid composed of carbon, hydrogen and oxygen in slightly varying proportions, of which the average is: Carbon, 82 to 87 per cent; hydrogen, 11 to 15 per cent, and oxygen, ½ to 6 per cent. The theoretical heating power is about 20,000 heat units per pound, which corresponds to a theoretical evaporation of 21 pounds of water from and at 212°.

Oil fuel has both advantages and disadvantages. The fire can be controlled by means of a single valve, and if once regulated to produce a certain heat it can be kept at that point with very little care. The fire can be started with slight trouble and if not wanted continuously can be extinguished instantly, there being no waste of fuel after the desired work is done. As compared with coal it is equivalent in heat value to nearly twice its weight of coal. A pound of coal under ordinary conditions will evaporate from 7 to 11 pounds of water, while oil tests show 17 or 18 pounds. The burning of petroleum is not as harmful to the furnace as that of coal, owing to the smaller amount of sulphur present. Complete combustion, cleanliness and economy of labor are important factors in the use of oil fuel.

Among the disadvantages may be mentioned the comparatively high price, danger from explosion, loss by evaporation and unpleasant odor. The price, however, depends largely upon the locality, and comparison must be made for each case individually. Crude petroleum is sometimes used, but the distilled oils are often preferred and are more efficient for a given weight. In using oil as a fuel it is thrown into the furnace in the form of a fine spray by means of a special nozzle in which superheated steam or compressed air is used as the motive force. Steam is more convenient, but not as good, on account of the large amount of moisture thrown into the furnace.

Gas has many advantages over all other kinds of fuel. Natural gas has been found in many localities in such quantities that many manufacturing plants use it exclusively. Coal gas made by the distillation of coal, and water gas produced by the decomposition of steam in the presence of incandescent carbon, have both been used for fuel. Table III shows the relative heating value of different gases.

TABLE III.

Relative Heat Values of Average Gases.

	By Weight.	By Volume.
Natural Gas	1000	1000
Coal Gas	949	666
Water Gas	292	130

The water gas considered in this comparison is not carbureted; when this is done it may be made to exceed the value of natural gas. The high value of natural gas is due to the large amount of marsh gas it contains, which makes it rich in hydrogen.

Experiments have been made which show the heat value of 1000 cubic feet of natural gas to be equal to that of an amount of coal varying from 80 to 130 pounds. Other authorities state that a pound of good coal is equivalent to 7½ cubic feet of natural gas. As in the case of petroleum, the economy of using gas for fuel depends largely upon the locality.

The Interstate Independent Telephone Association.

The first meeting of the Interstate Independent Telephone Association was held at the Sherman House, Chicago, April 9, 10 and 11. The new association is composed of the independent telephone men of Illinois, Indiana, Iowa, Kentucky, Michigan, Minnesota, Missouri, Ohio and Wisconsin, and was organized at this meeting. The first half-day of the convention, the morning of Wednesday, April 9, was devoted to registration and issuing credentials. In the afternoon Dr. I. A. Lumpkin, of Mattoon, Ill., called the meeting to order, and in a brief address outlined some of the causes which had led to the present meeting for the purpose of organizing an association. His explanation in part was that the chief object of the association was to bring about the establishment of long-distance toll lines from Chicago to the several states represented by delegates. The meeting then adjourned until Thursday morning. On Wednesday evening a banquet was given at the Sherman House by representative telephone manufacturers and supply houses, with the co-operation of the electrical press. This was attended by telephone instrument manufacturers, exchange owners and operators to the extent of about 500 persons. A somewhat unusual feature was an "auxiliary" banquet given solely for the benefit of the ladies in attendance; this was given in an adjoining room, and Mrs. George A. Briggs acted as toast-mistress. Mr. J. J. Nate was toast-master for the men's banquet.

THURSDAY MORNING.

At the Thursday morning session a committee was appointed to make up a slate for the officials of the new organization, and the delegates then listened to several interesting papers. The first one was a discussion of "The Future of the Business Part of Telephony," by C. F. Bennett, of Waterloo, Iowa. After touching on the methods of financing a modern telephone plant, Mr. Bennett said that the trend of methods of charging is not clearly seen yet. In one locality flat rates prevail, and in some foreign countries this seems to have stood years of competitive influence. In other localities the tendency is toward measured service, which likewise, in Europe, has its supporting argument. He saw equity in neither. A minimum flat rate is necessary in order to warrant an extension of the service on the measured rate plan, and he suggested a low flat rate for private telephones for a corresponding low measured rate per message, with a percentage of the latter to go to the one who pays the former and co-operates to increase the latter. He feared this was the outcome, expressing fear because it will be a costly one which should be long anticipated. Telephone business in the future will have many sub-divisions. Governmental influences may in the future reach as far as ownership. Certain it is that they will effect some of the following changes: remuneration for use of public ways; supervision of franchise rights; investigation of standard methods of construction to insure quality of service; restriction of tariffs, and the supervision of competition. These will harm little, and help greatly those who see farthest into the coming work. Mr. Bennett expressed the opinion that telephone men should be guided by the experience of the railway companies, and learn that they must deal with each other, remembering that the most dangerous method of doing good is to give more than value received. Regular balances between companies are the greatest bond of friendship he has known.

"The Telephone Situation in Wisconsin" was next reviewed by Richard Valentine, of Janesville, Wis. Mr. Valentine said that from conversations with telephone men from other western states, he concluded that the telephone business is growing beyond all expectations. In Wisconsin there are 176 independent telephone companies. Statistical reports received from a majority of them and a fair estimate of the balance shows 200 miles of copper metallic toll lines; 3000 miles of iron metallic toll lines; 4000 miles of iron grounded toll lines; 650 toll stations; 23,000 telephones in use, and a capital investment of $2,316,875. Of the invested capital $366,945 is represented by 16 companies that have been incorporated since January 1, 1902.

Much of the growth has occurred within the last three years. One of the most encouraging signs of the times is the rapid growth of the farmers' lines. They are going up in all parts of the State, and the construction is mostly complete metallic circuit. Farmers are the most enthusiastic customers, and it is a business to be cultivated. What independent telephony in Wisconsin needs most is an exchange in the cities of Milwaukee and Chicago and a system of copper toll lines.

The status of the independent franchise ordinance in Milwaukee was then briefly discussed, and the efforts of Bell interests to make working agreements with independent companies throughout the State were described and the making of such agreements condemned. In conclusion he said that in his opinion the weak point in the independent telephone movement is the great multiplicity of small companies, and he believed the time is not far distant when a movement for the consolidation of the small companies in each state will be adopted. Consolidation would bring economy in management, economy in the purchase of supplies and economy in construction. Under the present condition many small companies can be said to have no management whatever beyond an operator and the lineman. They are, therefore, the prey of makers of cheap instruments, dealers in common fence wire and vendors of bean poles, who tell them 15 poles to the mile is sufficient for any telephone line.

"With only one company in each state," he said, "we would have first-class instruments and the best of construction. We would have first-class copper toll lines and all the good things we long for. How this consolidation is to be brought about I will leave to your consideration, but that it is to come in time I have not the least doubt."

The next paper read was one on "The Future of the Independent Telephone Movement from the Operators' Standpoint," by H. C. Rainey, of Fairfield, Iowa. After dwelling on the remarkable development of the independent business during the past ten years, Mr. Rainey said that the remarkable and growing demand for telephone service is a guarantee of a prosperous future for the business and at the same time a dangerous element. It is a guarantee of prosperity because it is a healthy demand which must be supplied; the element of danger lies in the fact that people are almost wholly ignorant of the laws that govern the telephone business, which is not subject to the same rules that apply to an ordinary business. Most of the people have become possessed of the idea that telephone service can be obtained for almost nothing, and are therefore disposed to make demands for a low-priced service that cannot be complied with. The great reduction in price from the old Bell rates that were made by the independent companies may have something to do with this popular notion, but the most potent factor has been the misleading of farmers by manufacturers of cheap telephones, who have led the farmer to believe that any kind of telephone, together with a fence-wire line, would make a first-class telephone system; and the farmer, finding out that with such a system he can converse with a neighbor a quarter of a mile away, has accepted the idea and is acting accordingly.

This condition constitutes one of the greatest dangers that the independent exchanges have to face. When an exchange is established, with a small toll-line system, if some set of farmers are refused the free and unlimited use of the system, they proceed to build parallel lines, ask for a franchise, and start a competing exchange. Time and experience on the part of the farmer will evidently remove this trouble, but in the meantime it may have financially wrecked some small exchanges. If the independent companies will take a stand together and refuse connection to all exchanges except on strictly business principles,' this evil will be greatly minimized.

Mr. Rainey urged the consolidation of small companies and a greater community of interest between different companies. He thought this must develop along the line of a clearing house association and long-distance telephone companies made up of small independent exchanges. The long-distance toll line, he said, is one of the recognized things of the future; not lines hundreds of miles long, but those extending distances of from 25 to 150 miles. At least four-fifths of the so-called "long-distance" business is done within a radius of 100 miles. One of the best means of solving the long-distance question is improved construction and equipment. There is no longer anything to fear, he said, as to infringement of patents, but one of the dangers that will require attention is hostile legislation, and he strongly urged the avoidance of asking for too much legislation supposedly in favor of the independent companies. What is needed is to guard carefully existing legislation rather than to ask for more.

Mr. L. Frazee, of Connersville, Ind., then delivered a talk on "The Telephone Situation in Indiana." Mr. Frazee said that the situation in his state differs widely now from that of former days, and he related some of the adversities of these early days and compared the insignificant beginnings with the splendid developments of the present. He stated that there are 19,000 Bell telephones in use in Indiana as compared with 65,000 independent instruments. The present paramount issue, he said, is a question of conducting the telephone business at a fair profit. Referring to the fact that in exchanges of appreciable size, say 200 telephones or more, the greater the number of subscribers the greater the expense per subscriber for installation and operation, he pointed out that in most cases an exchange will grow to four or five times its original size. As it grows the lines average a greater length. There must be more cable lines, in many instances overhead work must be changed to underground, the old switchboard must be discarded and one costing more money per subscriber installed, and the larger exchanges must be changed to central energy. In addition to these difficulties the exchange is confronted with the farmer, who builds his own lines in the cheapest possible fashion and operates his system on 25 cents a month per telephone. "Then," he continued, "he comes in the form of a committee with powers plenipotentiary and calmly informs you that it will be to your interest to give him free connection with your exchange, or at least makes some proposition that is not feasible in view of operating an enlarged exchange."

He expressed the opinion that the city exchange should own all lines within a radius of at least five miles from the exchange. If service is needed farther than that and the farmers or villagers build an exchange, he suggested running one or more circuits, as might be necessary, and charging each subscriber 50 cents a month flat for the exchange connection. As a general proposition, he believed that a farmer should have the privilege of talking to his county seat without paying toll. Mr. Frazee then outlined his company's policy as to farmers' lines. His company furnishes all material and does all the work except hauling the poles and digging the pole holes, which work the farmers take care of; the company uses 20 ft. and 25-ft. poles, 32 to the mile. The circuit is a metallic one of No. 12 steel wire, put up on long cross-arms in order to avoid possibility of crosses. The company puts from five to eight 1600-ohm instruments on a line. It has one selective signal line which has been in operation about eight months, but this has not been considered a success, as it gives more trouble than the regular bridged telephones and trouble on the line is harder to locate. The rates to farmers are $15 a year in advance, or $4.50 a quarter in advance, and $1.66 a month for any rentals in arrears. Mr. Frazee did not approve of measured rates for the conditions existing in his state.

THURSDAY AFTERNOON.

At the opening of the Thursday afternoon session the nominating committee made its report, which resulted in the election of H. C. Raney, of Fairfield, Iowa, as president of the association; Dr. I. A. Lumpkin, of Matoon, Ill., vice-president; E. M. Coleman, Louisville, Kentucky, secretary, and J. C. Harper, of Madison, Wis., treasurer.

After the election of officers, Mr. E. R. Conklin, of Aurora, Ill., presented a paper on "Public Confidence in the Independent Movement," in which he outlined some of the necessary elements which should characterize the operation of independent companies. He strongly urged profiting by the history of the Bell Company, and paying necessary attention to the needs of the farmer calls. He pointed out the fallacy of making rates too low, and briefly touched upon the enormous growth of the telephone business and the importance of more and better toll connections for all companies.

FRIDAY.

At the Friday morning session a paper was read by W. H. Crumb, of Chicago, on "Telephone Construction," in which was discussed in great detail outside construction work. The constitution of the association, which had been prepared by a special committee, was then read and adopted.

At the afternoon session Mrs. Annie McElroy Brett, of El Paso, Texas, president and general manager or the Southern Independent Telephone Company and the Brett Telephone Construction Company, made a short address, advocating the education of the public as to the cost of telephone service with an increasing number of subscribers. This was followed by a paper on "The Cost of Construction and Maintenance of Telephone Plants," by Dr. H. S. Herr, of Ottumwa, Iowa, which is abstracted elsewhere. Dr. Herr's estimate of allowance for depreciation was criticised in the discussion which followed the reading of his paper, and a resolution was passed later to the effect that the sense of the association was that depreciation on a well constructed and well engineered telephone plant should not exceed 5 per cent per annum.

Following the discussion of Dr. Herr's paper, A. L. Hutchinson, of Weyauwega, Wis., read a paper on "Three Problems and Their Solutions." These problems were: "How shall the various companies earn sufficient capital to meet necessary demands?" "How shall rates for joint business be fixed?" and "How shall the joint business of the many companies be adjusted and settled?" As to the question of capital, Mr. Hutchinson strongly advocated the establishment of an independent telephone stock exchange through which the companies might sell their stocks and bonds. A telephone company properly managed, he said, can pay from 6 per cent to 10 per cent per annum on the cost of its plant over and above all operating expenses, maintenance and a small sinking fund for emergencies. A stock exchange could advertise and sell bonds cheaper and with greater facility than this could be done by an individual company selling its own stocks and bonds. Moreover, an exchange would know the character of a company and its condition, so that a purchaser of a company's securities would be assured as to their desirability without going to the trouble of making a personal investigation. Mr. Hutchinson stated that he had established such an exchange for the state of Wisconsin in the city of Milwaukee.

Concerning the rates for toll business passing over the lines of more than one company, he said that a committee of five appointed by the Wisconsin State Association is preparing a plan to cover this problem, which will be presented at the summer meeting of that association next June. He expressed the opinion that such a plan should be one in which every company whose lines afford a connecting link in the transportation of a message should share in the fees received; the fee to be charged should be based on the air-line distance between the sending and receiving station, and the portion of the fee paid to each company should be based on the air-line mileage of its lines between the point from which the message was sent and that at which it passed to another company or to the receiver. A slight advantage, he said, should be accorded to the sending and receiving stations.

Concerning the third problem of the adjustment and settlement of joint business, he advocated the establishment of a company having for its sole object the auditing and adjusting of such business within a certain district, preferably for an entire state. This company would serve as a sort of clearing house to which record slips should be sent weekly from each station of the companies involved. Record slips should be made of all messages sent by the different stations, and similar records made of messages received, so that the clearing company could compare the slips. At the end of each month the clearing company would send to each company having a balance to its credit a sight draft on each other company having a debit balance in that company's favor. The expense of thus auditing and clearing joint business, he estimated, could be covered by a fee of one cent per message from each company which received a portion of the fees for that message.

THE COST OF CONSTRUCTION AND MAINTENANCE OF TELEPHONE PLANTS.

BY H. S. HERR.

The proper understanding by the general public of the cost of construction and maintenance of a telephone exchange is as important in the telephone situation of to-day as it is that every telephone man should understand it for himself. This knowledge generally diffused among the people will be a safeguard against unwise legislation in telephone matters and ill-advised interference by town councils. The cost of construction is continually advancing; it is 50 per cent higher now than it was six years ago. Telephone wires, poles, insulators and cross-arms, and all material required in telephone construction, have advanced 10 or 15 per cent during the past year, and at the present rate of pole consumption it will be impossible in a few years to buy poles at any reasonable price.

Moreover, since it has been demonstrated that it is practicable to place wires in conduit along the principal thoroughfares, this will be required by all large towns in the near future, as it is now in larger cities. The demand is so great for telephone service that in order to supply the service in densely populated districts great networks of wires are required, and these will not be permitted to be maintained overhead in well regulated towns. The only solution will be underground conduit and cable construction, the cost of which is considerably more than that of the ordinary pole line with open wires and overhead cable.

The cost of a telephone plant can be estimated approximately on the basis of the number of telephones installed. An exchange of 500 telephones installed within a radius of 1½ miles without any conduit or cable work, but with up-to-date pole-line construction, will cost about $65 per instrument; this will come so near to the actual cost that a company may base its calculations on it with a degree of certainty. As the number of telephones increases, the radius or distance from the exchange will also increase, and therefore the cost per instrument. In estimating on a plant of 1000 telephones we must take into consideration some aerial cable and more substantial construction, as well as more costly equipment; consequently, there will be a material increase in the cost per instrument; without conduit work a safe approximate figure would be $85 per instrument within an ordinary radius.

When an exchange has more than 1000 subscribers, and quick, strictly modern service is required, it necessarily must be equipped with central energy and multiple switchboards, and in towns where electric light and railways are used many additional appliances are required to neutralize the interference from the heavy circuits. Where it is necessary to construct conduits we cannot with safety allow less than $100 per instrument for the installation. In large cities where 5000 or 10,000 subscribers are connected up, the cost would approximate from $150 to $200 per instrument.

The expense of operating an exchange of 1000 subscribers is much more than twice the expense of operating an exchange of 500 subscribers. At the beginning of the independent movement it was naturally thought that if 500 subscribers can be given service at $1 per month, such service can be provided for 1000 subscribers at a lower rate, but experience has proven that the reverse is the case. When there are 500 subscribers connected with an exchange, each subscriber can call up 500 (499?) others, and by the time every subscriber calls up every other subscriber there will have been sent through the exchange 250,000 (249,001?) calls. In an exchange of 1000 subscribers when every subscriber has called up every other subscriber once there are not merely twice as many calls sent through the exchange as in the previous case, but approximately four times as many. This requires practically four times as much labor to take care of 1000 subscribers as to take care of 500, and four times as much wear and tear on the apparatus, as well as much more central apparatus to perform the service.

The same thing is true of outside construction. Suppose that the first 500 subscribers are within a radius of one mile from the exchange, with an average of half a mile of pole line, or one mile of wire for a full metallic circuit. Suppose the second 500 come within a radius of two miles from the exchange, making their average radius 1½ miles for the pole line. The average length of wire per subscriber for the second 500 will be three miles, making the amount of construction for the outer 500 three times as great as that for the inner 500 subscribers. I doubt whether this covers the case when we consider the amount of territory that must be covered by poles and wires as the radius increases. The territory to be covered in a radius of one mile is only a fraction less than 4 sq. miles. The territory covered in a radius of 2 miles is four times that, or 16 sq. miles, requiring 12 sq. miles to be covered with poles and wires in order to serve the second 500 subscribers, and the total area of construction is four times as great for 1000 subscribers as for 500. The wires for the outer district can, of course, be carried on the same poles with the wires for the inner district within the limits for that district, but the poles will have to be much larger and cost more than if the wires for the outer district were not carried and the expense for cross-arms, insulators and wire is, of course, the same as though the wires were put on separate lines.

The average life of white cedar poles as they are supplied to-day is from 15 to 20 years. Galvanized-iron wire in towns and cities cannot be relied on for a period greater than six or seven years; in the country the life is much longer. The life of a switchboard is from 15 to 25 years or longer, but there is constant repairing and replacing of parts which give out or wear out as time goes on. The life of telephone instruments has been an uncertain quantity until within the last few years. There are a few telephones that have been used many years, but there are many that have been thrown away in a very few years.

The expense of maintenance when good up-to-date appliances are used, together with the very best construction, should not and does not exceed 3 per cent to 5 per cent, so that we are on the safe side when we make a 5 per cent maintenance fund and a 6 per cent dividend. As has been already stated, the cost of maintenance increases more rapidly than the number of subscribers. This is being understood by many, and is evidenced by the franchises granted in various cities, which contain a clause granting the privilege of increasing the rate for telephone service as the number of subscribers increases.

[The foregoing is an abstract of a paper read at the Chicago Convention of the Interstate Independent Telephone Association.]

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AN INTERESTING OIL ENGINE.

It is a well-recognized principle in the operation of internal-combustion engines that the introduction of heat energy into the working cylinder should be made at the highest possible pressure and that the discharge should correspondingly be made at the lowest possible pressure in order to secure maximum efficiency. It is because of this fact that high compression in engines of this class gives a high efficiency. With a given degree of compression it is also true that the efficiency of a gas or oil engine working with gradual combustion will be lower than that of a similar engine in which the fuel is burned explosively at the beginning of the stroke. In an engine of this kind the efficiency is independent of the quantity of heat introduced and depends entirely upon the pressure of compression. If the heat be introduced isothermally, the richer the gas or other fuel the lower will be the efficiency of the cycle. If the heat be added at constant volume the efficiency for a given quality of charge will depend entirely upon the degree of compression. Engines working with gradual combustion have the advantage that the heat is always introduced at the highest possible pressure, but with isothermal combustion the efficiency increases with the compression, but not to the same extent as with explosive combustion accompanied by rise in temperature.

Compression, however, cannot exceed certain limits on account of the excessive rise in temperature entailed. A novel method of increasing the permissible compression is embodied in the Banki oil engine, built by Ganz & Co., Buda Pesth, and illustrated by the accompanying engravings. The principle broadly consists of introducing water in the form of a very fine spray at the time that the charge is introduced into the cylinder, the effect being to keep down the internal temperature of the cylinder. This, of course, not only obviates the mechanical disadvantages due to excessive temperatures, but it reduces the heat loss by reducing the transmission of heat from the burning gases to the walls of the cylinder. During compression the spray or mist which has been introduced is reduced to steam and takes up much of the heat, and by suitably adjusting the amount of water spray delivered with each charge, the temperature of compression can be regulated to a nicety.

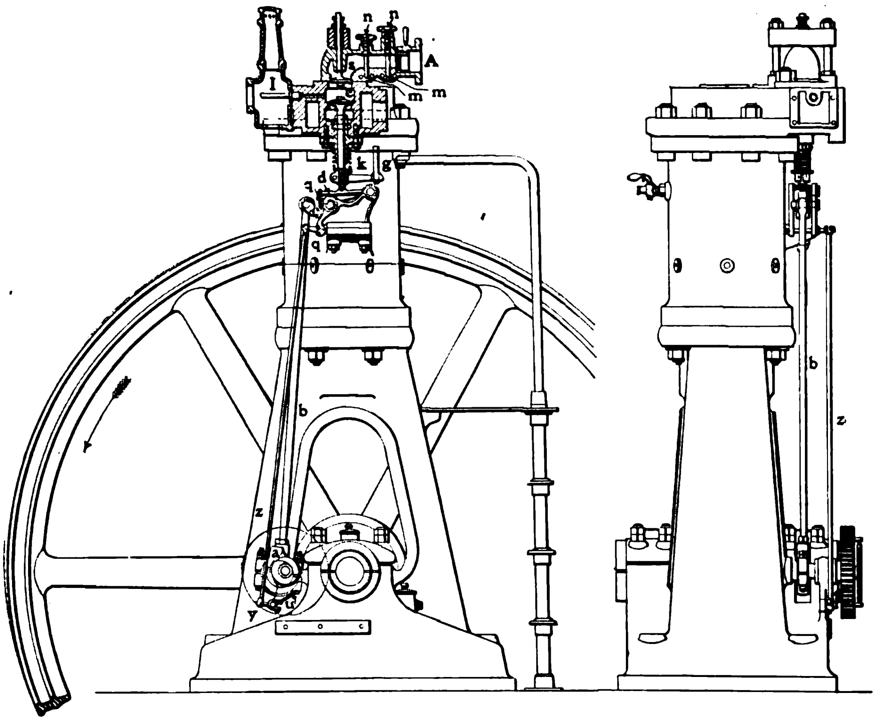


FIG. 1.—BANKI OIL ENGINE.—FIG. 2.

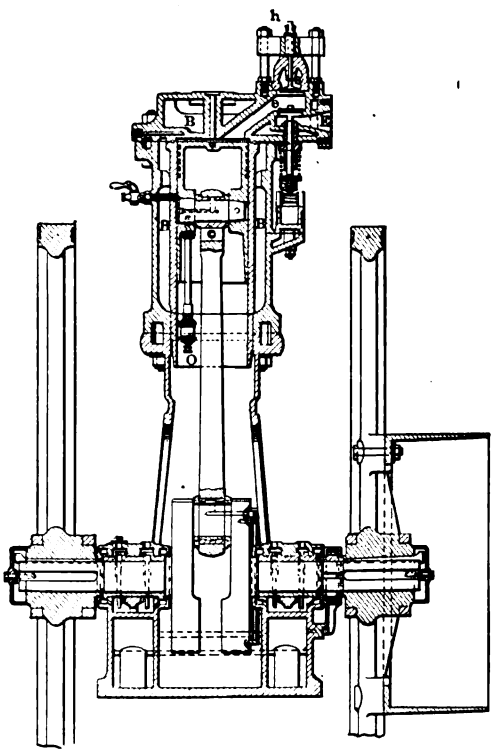


FIG. 3.—CROSS-SECTION OF BANKI OIL ENGINE.

The engine is of the ordinary Otto cycle type, taking in a charge of fuel on one downward stroke of the piston, compressing this charge on the next upward stroke and firing the charge at the beginning of the succeeding downward stroke and so on. Referring to the engravings, *A* represents the admission pipe, *B* is the water-jacket *E* is the exhaust outlet and *I* is the igniting tube. The cylinder-head is water-jacketed, as indicated in Fig. 3, this jacket being connected to the jacket around the body of the cylinder. The wrist-pin is provided with a peculiar oiler, indicated by *O* in Fig. 3, which communicates by means of a passageway through the center of the pin with an oil hole through the brass surrounding the pin. The admission of air is effected by means of an automatic valve, *s*, which is held closed by a very weak spring, *h*, so that the partial vacuum due to the downward motion of the piston will allow the atmospheric pressure to open the valve and admit the charge.

The oil and water are admitted through spraying nozzles, indicated by *m m* in Fig. 1, the quantity of oil and water being regulated by means of the thumb-nuts, *n n*. The water and oil are delivered by gravity to receivers containing small floats. This detail is shown clearly in Fig. 4, where *r* is the reservoir, *f* the float and *v* the automatic valve controlled by the float for shutting off the supply of oil or water when the desired quantity has been admitted; *n* is the thumb-nut shown in Fig. 1 for adjusting the amount of oil or water delivered to the cylinder, and *m* is the spraying nozzle.

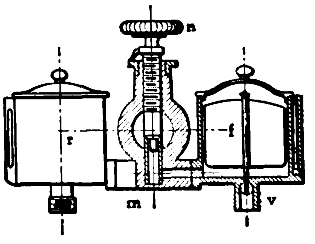


FIG. 4.—DETAILS OF NOZZLE AND FLOAT VALVE.

TABLE OF TESTS MADE ON A 20-H.P. BANKI OIL ENGINE.

Number of Test.	I.	II.	III.	IV.
Duration of test, hours	2	1	1	1
Revolutions per minute	209.13	209.67	209.83	210.50
Number of admissions per minute	91.44	74.68	60.12	42.65
Mean temperature of cooling jacket water, in; degs. Fah.	58	57	58½	58½
Mean temperature of cooling jacket water, out; degs. Fah.	121	112	123	127
Consumption of cooling jacket water per hour, lbs.	786.5	943	567.3	426.
Mean temperature of exhaust gases, degs. Fah.	384	384	366	341
Consumption of oil per hour, lbs.	12.8	10.7	8.6	5.8
Consumption of injection water per hour, lbs.	62.3	35.2	24.3	13.7
Ratio of oil and water consumption	1:4.8	1:3.3	1:2.8	1:2.3
Maximum compression pressure, lbs. per sq. in.	243	243	243	243
Maximum pressure during combustion, lbs. per sq. in.	660	647	617	573
Brake horse power	26.38	20.70	15.05	8.21
Consumption of oil per brake horse-power hour, lbs.	0.48	0.51	0.57	0.71
Consumption of water per brake horse-power hour, lbs	2.36	1.60	1.62	1.67
Consumption of cooling jacket water per brake horse-power hour, lbs.	29.8	45.5	37.6	51.8
Specific gravity of oil at 59 degs. Fah.	0.73	0.73	0.73	0.73
Heat value of oil, thermal units, per lb.	18,323	18,323	18,323	18,323
Percentage of the total heat carried off in cooling water	21.7	26.7	23.6	27.6
Percentage of the total heat turned into actual work	28.0	26.4	23.8	19.0

The passage from the admission valve, *s*, to the cylinder is clearly shown in Fig. 3, which is a cross-sectional view on a plane parallel to the shaft. The exhaust valve, *e*, is operated by a short lever, *d*, which is in turn lifted by a curved cam lever, *c*, actuated through the medium of the rod, *b*, by an eccentric on the secondary shaft, geared to the main shaft in the ratio of 2 to 1, as usual. The valve-lifting lever and cam lever are shown more

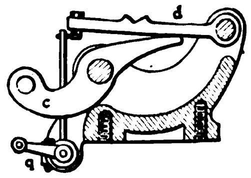


FIG. 5.—DETAILS OF LEVERS OPERATING EXHAUST VALVE.

clearly in Fig. 5, which is an enlarged view. The small rocker-arm, *q*, is controlled by the governor through the medium of the rod, *z*, Fig. 1, and operates to hold the exhaust valve open when the speed becomes excessive. This method is used in many American engines and does not need further discussion.

The governor is shown in Fig. 6. It is mounted within the gear-wheel on the secondary shaft and is of the ordinary double-weight type, the weights being indicated by the letters *w w* and connected by a link, *l*. One weight is provided with a pin, *u*, which strikes against a spring finger, *x*, attached to the small rocker-arm, *y*. Whenever the speed exceeds the proper rate, the contact between the pin and the spring finger occurs at the proper moment to open the exhaust valve in time to relieve the atmospheric pressure due to the downward motion of the piston on the charging stroke and thus prevent admission of the charge by the valve, *s*. As an additional precaution, the exhaust valve carries an arm, *k*, which lifts a rod, *g*, and compresses a spring on the spindle of the admission valve, *s*, increasing the pressure of that valve on its seat.

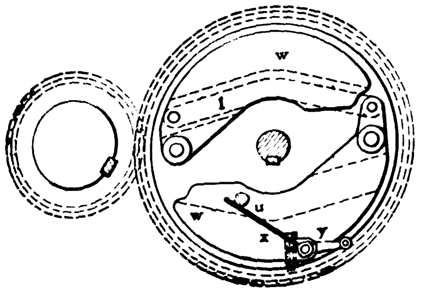


FIG. 6.—BANKI OIL ENGINE GOVERNOR.

The engine here shown is a 20-h.p. machine, having a cylinder 9.8 ins. in diameter with a stroke of 15.7 ins., a cylinder volume of 0.6936 cu. ft. and a compression space volume of 0.0787 cu. ft. The compression ratio is therefore 9.95 to 1, or practically 10 to 1. The consumption of oil per horse-power hour as shown by tests made by Prof. Jonas, of the Buda Pesth Technical High School, and Mr. Taborsky, Director of the Hungarian Technological Museum, is very low. The results of these tests are given in the accompanying table, for which, together with much other data herewith, we are indebted to the London *Engineer*. Another feature shown by the tests is that the consumption of oil per brake horse-power increases very slightly with a decrease in load. This is shown by the third and fourth tests, the one at three-fourths rated load and the other at less than half load. The quantity of water introduced with the oil increases much more rapidly than the quantity of oil. It is further notable that the products of combustion leave the cylinder at a lower temperature than is usual in such engines, and that the percentage of heat carried off by the circulating water is not much more than one-half the usual amount. The pressure of compression is extremely high, being, in fact, higher than that used in any other engine with which we are familiar, except the Diesel.

THE ELECTRIC ELEVATOR.

BY H. D. JAMES.

GENERAL FEATURES.

Elevators are divided, as to motive power, into steam, hydraulic, electric, hand power and belted machines, or machines which receive their power from an independent prime mover by means of one or more belts. Other sources of power have been tried, but have not come into general use. This article will deal only with the electric elevator. The mechanism of this differs with the different kinds of service it is called upon to perform; the passenger elevator, of course, is the most important class.

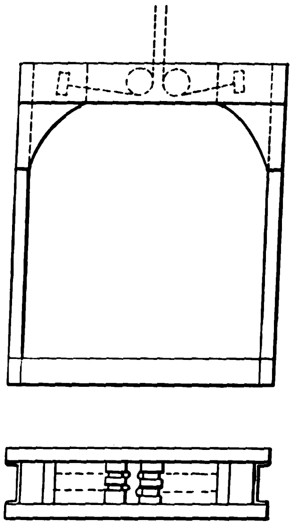


FIG. 1.—METHOD OF FASTENING LIFTING CABLES.

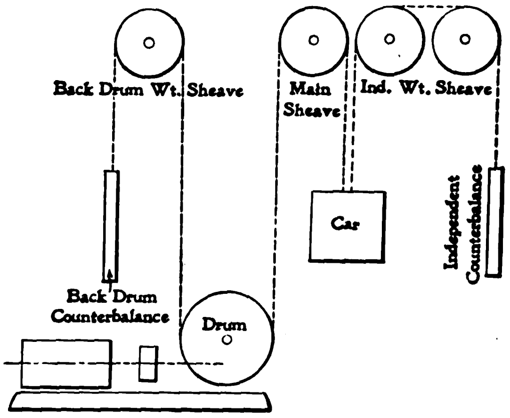


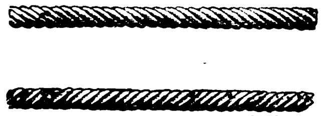
FIG. 2.—METHOD OF CONNECTING THE COUNTERBALANCES..

The car should be kept as light as possible, for its weight, even if balanced, adds to the size of ropes and moving parts, thus reducing the efficiency of the elevator. Moreover, in case of accident it adds to the weight that the "safety" is called upon to stop and throws a heavier strain upon the rails. Too little attention has been given to this in the past. The car is fastened in a steel sling to which the ropes, safety device and guide shoes are attached. This sling is generally made in the shape of a rectangle, the sides formed by channels and joined together at the bottom by one or two channels, and the top (or "head") being made either of two flat bars or two channels. The lifting ropes are brought down part way round two 5-in. or 6-in. cast-iron rolls and then fastened to a cross-bar in the head, as shown in Fig. 1. Modern practice is to place the "safety" in or under the bottom channel, thus enabling it to act directly on the car bottom. The safety is operated by a centrifugal governor; it consists of some form of mechanism for clamping the guide rails and stopping the car when its speed exceeds a certain predetermined limit. Very few safety devices operate by the actual breaking of the ropes, as this only complicates matters; moreover, the governor will stop the car if its speed is too high either from this or any other cause.

The kind of safety to be used should be determined by conditions of load and speed, its resisting power being from 25 per cent to 35 per cent greater than the total weight of car and load. Fast speeds require more force to stop the car, of course; some safeties that are very satisfactory on slow speeds would not do at all when the car travel exceeds 150 or 200 ft. per minute. The ropes are almost invariably steel cables and are run in pairs, two from the car to the hoisting machine; two from the machine to the counterbalance, and if the car is large, two from the car to an independent counterbalance, as indicated in Fig. 2. These are so placed that the tendency of the two ropes to twist is neutralized; this is effected by running the cables with opposing twists, as in Fig. 3.

The total strain on the cables is the tension due to the load and the strain due to bending over the sheaves. The tension per square inch due to the load should be kept low to allow a liberal margin for the strain due to bending, and room should be provided for sheaves, of large diameter, in order to reduce the bending strain. The factor of safety for load tension should be about 10 in passenger work. Two ropes should always be used from the car to the machine, and two from the machine to the drum counterbalance.

All drum and duplex-type electric machines are overbalanced; in the drum machines this is accomplished by leading the car ropes up from one side of the drum and the machine counterbalance ropes from the other, the weight of this counterbalance being equal to the weight of the car and 40 per cent or 50 per cent of the load, so that when the car is about half full the system will be balanced and the machine has to overcome friction only. With this arrangement the maximum duty of the machine can never exceed more than 50 per cent or 60 per cent of the maximum load in the car. When the car is large or the load about 2,000 pounds or more, an independent car



Am. Elec.

FIG. 3.—OPPOSITELY STRANDED CABLES.

counterbalance is used to take some of the strain off the hoisting ropes and the machine. When this car balance is used its weight should be deducted from the machine counterbalance. When the machine is small, an independent weight has to be used for even small loads, in order not to overstrain the drum shaft and casing.

The duty of a machine is the number of pounds it will lift at a given speed. The tendency of to-day is towards more moderate speeds, especially for private residences, apartment houses, stores, etc., where the rise is 50 or 75 ft. The general practice is about 150 ft. a minute for 1500 to 2000-lb. loads, and 100 ft. for 1000 lbs.; 2000 lbs. at 200 ft. a minute is a very good duty for a 100-ft. rise. The proper load for a car is estimated on the assumption that each person occupies two square feet of floor space; as the average weight of a person is 150 pounds, this gives a load of 75 pounds per square foot of car floor, which agrees very closely with experience. If the car is too large, a seat is often put in to prevent overloading. But a large car is bad, as it increases the friction and has to be made correspondingly strong, which increases the cost. High speeds are not desirable where they can be avoided, as they require a larger machine and more expensive controllers and safety devices, which may materially increase the cost of the elevator equipment.

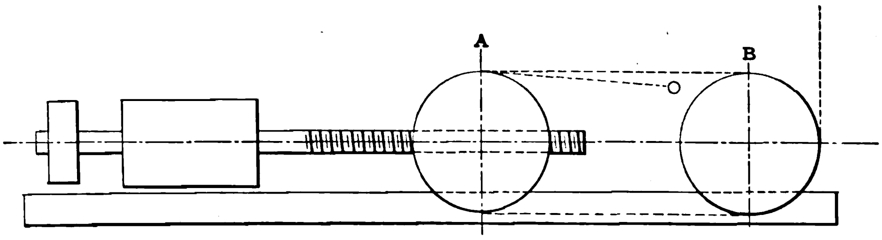


FIG. 4.—PRATT-SPRAGUE SCREW MACHINE

The machines for electric passenger elevators are the drum type, the screw type, the duplex motor type and the friction sheave type. Of these the drum type is by far the most common. The gear should be made of a hard quality of bronze and the worm a solid steel forging; they are both enclosed in a cast-iron case and run in oil. To avoid vibration in the car the gearing should be carefully and accurately made, and the bed, drum shaft and casing very stiff. Good practice is to have a factor of safety as high as 9 or 10, although there are machines on the market with less margin than this. Where the breaking of a single part may endanger lives, it is better to put more in material and less in lawsuits. Cheap elevator construction in any case is neither desirable nor profitable.

It is common practice to mount the bronze gear on a heavy cast-iron center, the outer end of which has about four arms; to these arms the drum is bolted, often through the medium of an elastic washer. In this way the driving is done through a solid center and does not depend upon keys; a light feather is all that is used. The coupling which connects the motor to the worm shaft is generally used as a brake wheel. The motor should be arranged so it can be insulated from the rest of the machine.

One of the most important things to take into consideration with alternating-current motors is the heavy flow of wattless current when starting. This does not occur once or twice a day, as with other kinds of service, but often once or twice a minute. It is the thing most often overlooked by contractors and power station men, who consequently attempt to run these motors and electric lights off the same generator with unhappy results. For motors of over 5 horse-power starting devices should be used to reduce this rush of current.

The drum type of machine is not generally used for speeds greater than 350 ft. per minute. The screw type with the multiple sheaves can run at about 500 ft. per minute and the duplex motor type at about 600. Most of the very high speed machines at present are hydraulic. What the future has in store is a matter of conjecture.

Where the speed is 100 ft. or over, the same machines are used for freight service as for passenger work, but when the speeds are low, from 40 to 75 ft., for example, additional gearing is introduced to enable heavier loads to be lifted. A pinion is placed on the worm gear shaft, which engages with an internal gear bolted to the drum; this arrangement also requires a heavier drum shaft to be used. The friction loss is increased by this construction, but a much smaller machine can be made to lift the load. Either a hand rope or a switch may be used to control these machines. The electrical connections are similar to those used for passenger service. The material in these elevators can be strained about 10 per cent more than in passenger work, as the speeds are slower, thus reducing the liability to sudden shock while running. Some freight elevators are operated automatically by a push-button at each floor, not even an operator being allowed to ride in the car; these can have a still smaller factor of safety. They are nothing more than big dumb-waiters and come logically under that head. Freight elevators are often equipped with some form of semi-automatic gate to close the opening in the hatchway when the car leaves the landing.

The Pratt-Sprague screw machine has been described so often within the past few years as to need no detailed explanation here. It consists broadly of a long screw, on one end of which are mounted the motor and brake, and along which travels a ball-bearing nut to which are attached the traveling sheaves, as indicated diagrammatically in Fig. 4. The cable is anchored at one end, and led around the traveling sheaves, *A*, and the fixed sheaves, *B*, several times before going to the car. The number of laps of the cable determines the gear of the machine. As the sheaves separate, the car ascends in the hatchway. These machines take current only when the car is going up. Coming down, the brake is released and the motor is driven as a dynamo by the car; a suitable resistance is connected to the brushes of the motor. This machine takes a large current on the upward travel, as all the work is done then; the motor has to lift the total load in the car and the unbalanced weight of the car, while with the drum type the whole of the car weight can be balanced and one-half the load. Although the total consumption of energy may be the same, its distribution is different. Where screw-type machines are installed, provision must be made for this large flow of current. These machines are for high duty and are designed to compete with the hydraulic elevators in large office buildings. They can easily give a speed of 500 feet per minute and lift 2000 or 3000 lbs. load. Most of those running in New York have been cut down to 400 ft., as this speed is sufficient to maintain the proper schedule.

Duplex motor machines are so called because the machine consists of two motors, the gearing being done with sheaves and an endless rope. It is a differential machine, the speed of the car depending upon the difference between the speeds of the two motors. Fig. 5 is a diagram of this arrangement, in which *M*1 and *M*2 are sheaves driven by independent motors. The car is counterbalanced by the sliding weight, *W*, in the usual manner, and this counterweight carries a sheave at the bottom. An additional weight, *w*, is mounted within the main counterweight and suspended from the cable, *b*, the other end of which is attached to a sliding guide frame, *G*, which carries a sheave at the bottom. The weight *w* is free to slide in the frame of *W*. Around the sheaves at the bottom of the frame, *G*, and the counterbalance, *W*, and the drums *M*1 and *M*2, an endless cable, *a*, is carried which is maintained in tension by the weight, *w*.

So long as the two motors run at the same speed, the cable *a* will simply be drawn through the sheaves without imparting any motion to the car. If the motor *M*1 be made to run faster than the motor *M*2, the left-hand stretch of the cable *a*, to the right of *M*1, will be drawn down more rapidly than it is paid out by the motor *M*2, the result being that the counterweight *W* will be pulled down and the car hoisted. The difference in speed will also pay out the cable *a* on the left-hand side of *M*1 faster than it is drawn in on the left-hand side of the drum *M2*, allowing the sliding frame, *G*, to rise at the same rate of speed at which the car weight, *W*, is pulled down. The counterweight, *W*, must be lighter than the car to a sufficient extent to allow the latter to overhaul at the proper speed when descending. The weight *w* overbalances the sliding frame, *G*, and assists in counterbalancing the car. When the system is in use the motors are kept constantly running, but the connections are such that the motors can be shut down from the car in case the system remains out of use five or ten minutes, or a longer period.

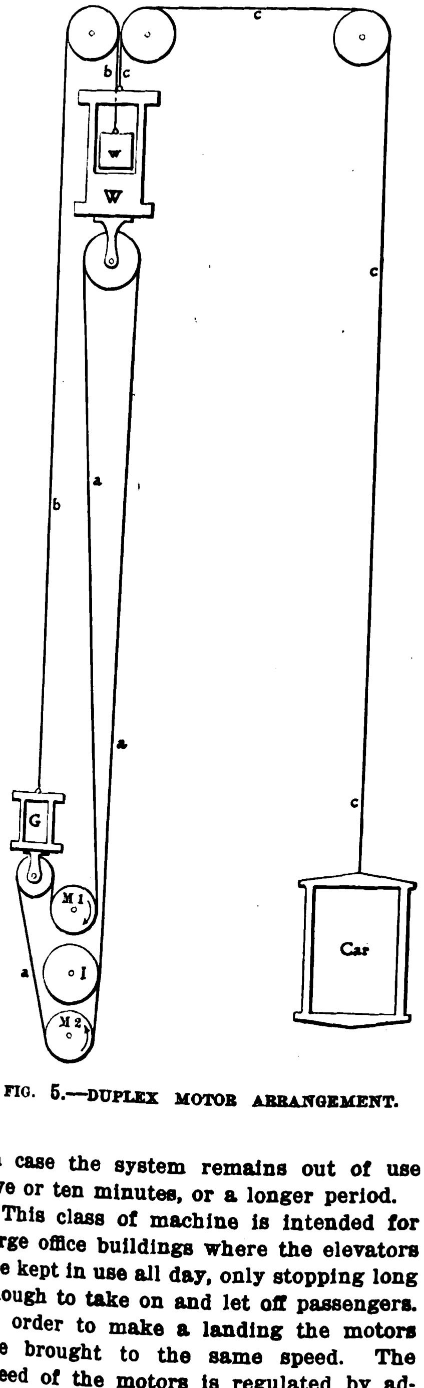


FIG. 5.—DUPLEX MOTOR ARRANGEMENT.

This class of machine is intended for large office buildings where the elevators are kept in use all day, only stopping long enough to take on and let off passengers. In order to make a landing the motors are brought to the same speed. The speed of the motors is regulated by adjusting the strength of the field magnets. The armatures are in parallel across the supply mains, and the fields in series. The field of the hoisting motor is shunted by a variable resistance, thus weakening its field and strengthening that of the other motor; the hoisting motor then takes more current from the line, which assists its acceleration, while the other machine generates current, causing it to slow up. The extra flow of current from the line is small, as the motor *M2* supplies most of the extra current taken by *M1*.

The efficiency of this outfit is high, as the rope gearing consumes less energy than the worm gearing of the standard drum-type machine, and machines of this type can be run as high as 700 or 800 ft. a minute, but such speeds are undesirable. The cost of the extra motor is offset by the absence of worm gearing, bed, drum, etc., of the other type of machine, and the wear comes on the ropes instead of the gear. This apparatus is the latest development in the electrical elevator line, and its details are still being perfected. Its future seems bright, but it is too soon to pass competent judgment upon it.

The friction sheave machine has not been developed for passenger service, as yet; very few have been installed, and the few I know of have been only for light duty. Its present field seems to be the dumb-waiter service. It is built exactly like drum machines, except in place of the drum there is mounted a sheave with V grooves, for the ropes to pass over. Its advantages are compactness and an unvarying lead of rope, which makes it a convenient machine to place overhead.

The starting and stopping of an elevator may be controlled either mechanically or electrically. Mechanical control may be effected by means of a hand rope, a wheel or a lever, connected with a "shipper drum" on the machine by means of suitable iron or steel cables. The "shipper drum" (or operating sheave) is connected mechanically with the reversing switch and the brake. The motor is in series with the reversing switch and a starting box of some kind. The resistance in this box may be cut out by means of gravity and a dash-pot; a solenoid and dash-pot; a number of magnets connected across the armature, the strength of the magnets depending upon the speed of the armature; a pilot motor; or a combination of two or more of these principles. In the larger sized machines, the brake is often released by a magnet instead of by a lever connected to the shipper drum. In these machines, in addition to this brake, the armature is short-circuited through a gradually-reduced resistance, forming a dynamic brake. In order to obtain a smooth and effective stop the brake requires a good deal of skill in designing and manufacture. The hand rope is suitable for speeds up to 150 or 200 ft.; for higher speeds, the more expensive electrical control should be used.

Electrical control is commonly effected by means of a switch in the car, controlling a special circuit which operates first the brake magnet, then the electric reversing switch, and finally sets in motion the apparatus for cutting out the armature resistance. Current should never be put on the motor before the brake has been released. The switch control is very flexible and can readily be arranged to give two speeds; the slow speed being used to make the landings accurately. This is the best control for machines above 10-h.p., but more expensive than the mechanical. The latter control is now arranged to give two speeds on all high-duty machines.

For small-sized electric machines, especially those in private houses, the control most used is the single push-button or automatic control. It consists of a button at each floor, which brings the car to that landing from whatever part of the hatchway it happened to be when the button at each floor, which brings the car to button needs to be only momentary. The car stops in front of the landing and the door is unlocked automatically by means of a cam fastened to the car. A passenger can then open the door, breaking the operating circuit and preventing the car from being again moved until the door is closed tight. On entering the car, the car button corresponding to the floor which the passenger wishes to reach is pressed. After the car leaves the floor the door cannot be again opened until the car returns to that floor.

The most approved form of door lock and contact is one in which the operating circuit is broken before the latch is released, thus preventing any chance of accident. This is the most expensive control, but it is absolutely safe for private houses and can be used by anyone, a special operator being unnecessary. It is not suitable for speeds over 150 ft. or for heavy loads; the duty of this class of elevator is generally 1000 lbs. at a speed of 100 ft., the car being about 3 ft. or 3 ft. 6 ins. x 4 ft. in size. This device has been used very seldom for alternating currents, as it still needs further developing in this line.

For alternating currents, the small-sized motors are connected directly to the line by means of a reversing switch, while for the larger sized machines a starting resistance is used in addition to the switch. Where possible this resistance should be in the secondary or rotor circuit; when the rotor is of the short-circuited kind without collector rings, the resistance has to be placed in the primary circuit, of course. Since the torque varies directly as the square of the voltage, this arrangement gives a very poor starting torque; but it is often used because it can be readily applied to existing machines without changing them. This resistance is cut out by means of a mechanical connection with the shipper drum and a dash-pot to give it the proper time element.

An automatic stop is invariably provided which opens the main line at the top and bottom limit of the car travel; this is operated directly from the drum shaft by means of the proper gearing, and it is arranged so that it will operate after a certain number of revolutions of the drum in either direction.

Abstracts from Foreign Contemporaries

Novel Hydrocarbon Engine.—Apart from the desirability of obviating the danger which attends the use of highly volatile petroleum spirit in oil engines, the question of the difference in cost of the heavy oils and the spirit is of quite sufficient importance to encourage perseverance in the direction of producing an oil engine that can utilize ordinary heavy oils without becoming clogged by gummy deposits resulting from combustion. A brief description of a novel form of engine, in which this problem appears to have been attacked with some success, is published in a recent issue of the London *Engineer*. The engine is the invention of R. O. Allsop, of London. It has two horizontal cylinders, the pistons of which are connected to two cranks on the same shaft and set at an angle of 180 degs. with each other. The larger of these cylinders provides the motive power, and works on the ordinary Otto cycle. The smaller cylinder acts as a pump, drawing in, vaporizing and compressing the charge, and works on a similar cycle, but does not ignite the contents. Starting from rest, the complete cycle of operations of the two cylinders is as follows: On the first outward stroke of the piston of the pump, the necessary quantity of oil and a small volume of air are drawn in; on the return stroke the oil is vaporized by the heat of compression added to the heat of the engine; on the third or outward stroke the vapor is expanded, and on the fourth the vapor is discharged through a non-return valve into the motor cylinder. The cycle in the larger cylinder begins with an outward stroke simultaneous with the inward movement of the pump piston, and as the capacity of this cylinder is greater than that of the pump, a partial vacuum is created. This serves to draw in through a separate air valve additional air to support combustion, and this is mixed with the charge from the pump cylinder. The large cylinder then completes the Otto cycle. On the return stroke it compresses and ignites the charge forming the outward stroke, and on the final or inward stroke the products of combustion are discharged. The exhaust from the engine using tea-rose oil is invisible, and practically inodorous. The claims are that perfect combustion of heavy oils is attained by decomposing the hydrocarbon by pressure and heat prior to its being delivered into the motor cylinder, and that practically no condensation takes place on the walls and other surfaces of the cylinder. When starting the engine it is necessary in addition to turning the fly wheel to apply heat to the vaporizer; but when the engine has been running some time this extraneous heat is not found necessary. It would appear that the essential feature of difference between this engine and earlier types of engines which employ both a motor and a pump cylinder, is that in this instance the pump compresses the hydrocarbon vapor and a small quantity of air without igniting the mixture previous to and in addition to the compression of the Otto working cycle, for the purpose of gasifying the oil.

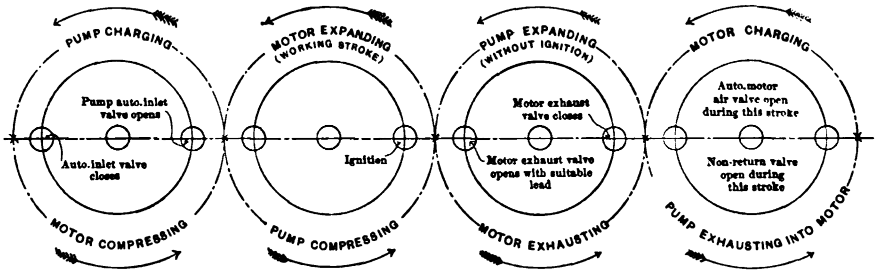

PUMP CHARGING
Pump auto.inlet valve opens
Auto.inlet valve closes
MOTOR COMPRESSING
I.
MOTOR EXPANDING (WORKING STROKE)
Ignition
PUMP COMPRESSING
II.
PUMP EXPANDING (WITHOUT IGNITION)
Motor exhaust valve closes
Motor exhaust valve opens with suitable lead
MOTOR EXHAUSTING
III.
MOTOR CHARGING
Auto.motor air valve open during this stroke
Non-return valve open during this stroke
PUMP EXHAUSTING INTO MOTOR
IV.
Am.Elec.

FIG. 1.—CYCLE OF OPERATIONS, ALLSOP HYDROCARBON ENGINE.

Gas Engine Sparking Device.—T. H. Hawley describes in a recent issue of the *Model Engineer and Amateur Electrician* the De Dion contact breaker and advance sparking device for gasoline engines. Fig. 2 shows the complete device with the outer cover removed. The terminal *M* is connected with the binding post *Q*, carrying the contact screw *B*. The circuit is closed when the platinum-tipped end of *B* comes in contact with the platinum-tipped surface of the vibrator *T*, the post *P* being connected to the terminal *N*. *R* is a locking screw for holding the contact screw *B* in position after adjustment; *C* is a cam mounted on the half-speed secondary shaft of the motor. The action of the contact breaker is as follows: When the shoe on the vibrator *T* falls into the notch in the cam *C* contact is temporarily made between *B* and *T*, closing the battery circuit through the primary of the induction coil, and a spark is produced at the ignition plug. Theoretically, this contact breaker should produce a stream of sparks by reason of the vibratory action of the spring blade; but the author says that much doubt exists as to whether this repeated sparking ever really occurs, and its value is dubitable, since one strong spark is sufficient to explode the mixture.

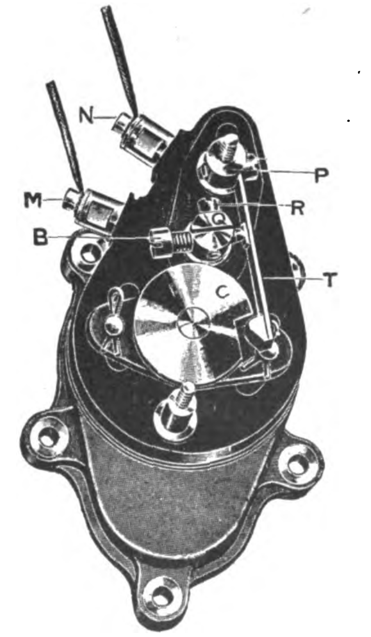


FIG. 2.—DE DION SPARKING DEVICE.

Hot-Wire Recording Voltmeter.—The Richard hot-wire recording voltmeter is described in a recent issue of the London *Electrician*, and shown by Fig. 3. In this instrument the wire heated by the current is composed of an alloy, the resistance of which is said to be practically independent of variations in temperature. One end of the wire is fixed to a compensator to allow for differences of temperature in the surrounding atmosphere. The wire passes backwards and forwards over a series of pulleys, and the other end is fixed to the short arm of a lever, the long arm of which is attached to a wire passing round the drum carrying the needle and terminating in a spring which keeps it in constant tension. The current taken by the instrument is said to be 0.18 ampere at its maximum reading. Means are provided to loosen the tension of the working wire for transport so as not to break it, and the readjustment consists in merely turning a key until the needle rests at zero.

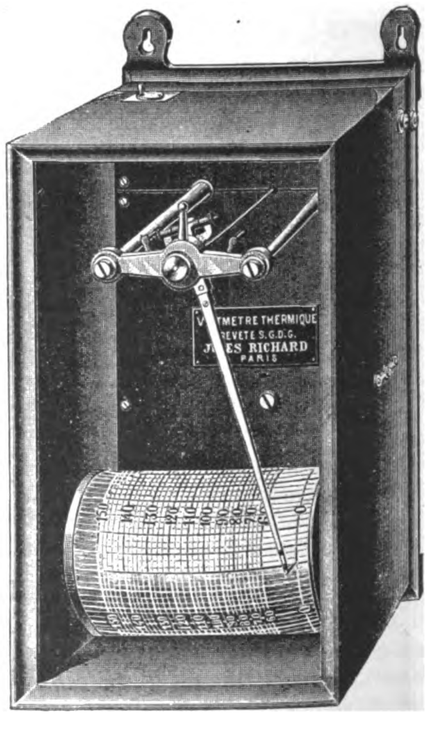


FIG. 3.—HOT-WIRE RECORDING VOLTMETER.

Return Steam Trap.—Fig. 4, herewith, shows a sectional view of a new form of return steam trap recently brought out in England and described by the the London *Engineer*. A copper float, *A*, is contained in a cast-iron case, *B*, and provided with a central vertical rod, *C*, which acts as a guide, sliding in bearings at the top and bottom. The top of the rod is elongated and has fitted to it an equilibrium valve which covers and uncovers the ports, *E* and *F*, in the valve box, *G*. The prolongation of the rod passes through a stuffing-box and connects with a tumbler action, *H*, through the link, *J*. This tumbler action is a device designed to give a positive action to the valve, *D*, so that it does not depend entirely upon the movement of the float to actuate it. It consists of a frame, *H*, pivoted at *I*, and containing a roller, *K*, which, though it can roll from end to end of the frame, cannot escape from it. *L* is a syphon pipe dipping into a recess in the bottom of the float and connected through the branch, *M*, to the check valve, *N*, and thence direct to the boiler. On the other side of the case there is a check valve, *O*, through which the condensed water enters the trap. It is essential for the proper working of the trap that it be connected not less than four feet above the surface level of the water in the boiler. The connection from the valve, *N*, to the boiler must enter the latter at some place below the water level, and there is also a steam connection from the boiler to the port, *E*, of the valve, *D*. The action of the trap is then as follows: The condensed water enters through *O* and gradually fills *B* to such a height that it overflows into the float, *A*, and causes it to descend, carrying the rod, *C*, with it. This opens the port, *E*, allowing steam to enter the trap from the boiler. The downward motion makes the roller, *K*, tend to assume the position shown by the dotted lines, and this gives a positive action to the valve and closes the port, *F*, which previously had been freely open to the atmosphere. When the steam enters the case, *B*, there is obviously an equilibrium of pressure between it and the boiler, and hence there is no reason why the condensed water should not flow by gravity into the boiler, through the syphon pipe, *L*, and the check valve, *N*. This action restores the buoyancy of the float, *A*, which rises and causes the port, *F*, to be opened to the atmosphere and the port, *E*, to close, so that the supply of boiler steam is cut off. Meanwhile the roller, *K*, rolls to the inner end of the frame, *H*, thus lightening the load on the float and ensuring a positive movement of the valve. Of course, as soon as the steam pressure within the casing is relieved by connection to the atmosphere the condensed water again begins to enter the trap, and the cycle of operations is continued. It will be observed that the trap does not depend upon any difference of temperature for its operation.

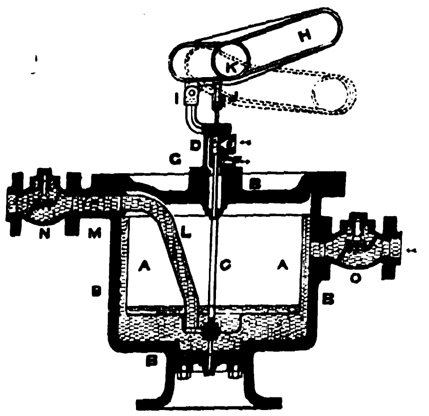


FIG. 4.—SECTION OF RETURN STEAM TRAP.

Two Simple Forms of Resistance.—The *Zeitschrift fuer Elektrochemie* describes two simple forms of adjustable resistance, one for dealing with fairly large currents, and another for small currents. The first is a metal resistance designed by Haber and used by himself and Geipert in an experimental investigation relating to the electrolytic reduction of alumina. By its use the danger of overheating and of fire is said to be entirely avoided. Fig. 5 is a sketch of this apparatus. It consists of a large number of nickel tubes, placed parallel and joined at their ends to one another by U-shaped couplings. The end tubes are joined by rubber tubing to some water supply and to the waste pipe. The gaps between the neighboring tubes are provided with sliding bridge pieces of brass or nickel, which can be fastened by a thumb screw in any desired position. When all of the bridge pieces are at the top end of the resistance, the whole of the current passes direct to the apparatus through the heavy U-shaped couplings and the bridges, whereas when all of the bridge pieces are at the bottom of the resistance, practically the entire length of the nickel tubing has to be traversed by the current. By adjusting the various bridge pieces the current can be regulated within very close limits; and as the nickel tubes are kept cold by the constant flow of the water through them, the trouble caused by the variations due to heating in the ordinary forms of resistance is avoided. The second form of resistance is of the liquid type as shown by Fig. 6. The U-tube in which the resistance liquid is contained is formed with enlargements at its upper ends, and is provided with an elongation at the bottom of one leg and an escape cock at *H*. The mouth of one leg is covered with a flat cork disk at *K*, and through this the glass rod, *G*, slides easily. The electrodes are fused in the glass at E_1 and E_2. The variation in the resistance is effected by sliding the glass rod, *G*, up and down in the tube containing the electrode, E_1. As shown in the diagram, the rod, *G*, nearly fills the narrower part of this tube, and only a very thin body of liquid is then present by which the current can travel from W_1 to W_2. By using a modified form of the apparatus with two additional legs containing sliding rods, and with electrodes connected in parallel, it is possible to regulate the current within very wide limits.

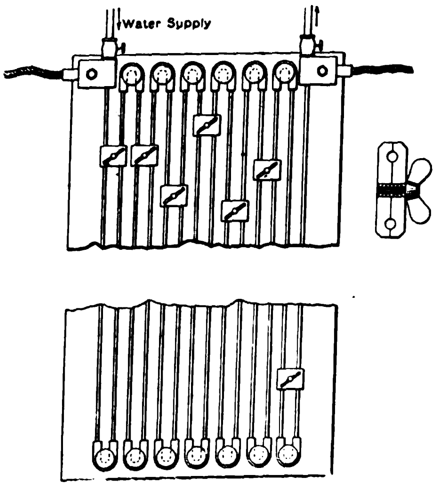


FIG. 5.—HABER RHEOSTAT.

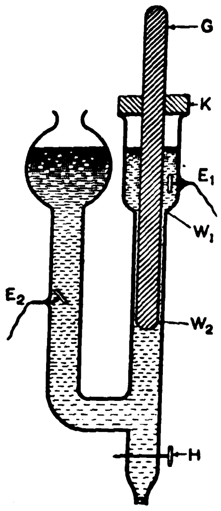


FIG. 6.—LIQUID RESISTANCE.

Electrical Brake Dynamometer.—Fig. 7, herewith, shows a dynamometer of the electrical absorption type recently described in the London *Electrical Times*. The dynamometer consists of a magnetic system of two or more poles arranged so as to be capable of rotating through a small angle, and mounted on ball bearings to reduce the frictional resistance to a minimum. The magnetic system may be excited by a dynamo or storage battery, the latter being preferable where great accuracy is desired. A cylinder of iron surrounds the poles, and when this is driven by the power which is to be measured, eddy or Foucault currents are generated in the iron ring and these currents exert a braking effort upon the rotation of the iron cylinder. By suitably varying the excitation the dynamometer

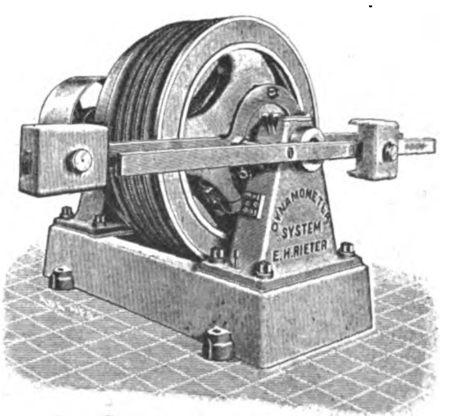


FIG. 7.—RIETER DYNAMOMETER.

may be made to absorb the exact power required. The heat is dissipated in the surrounding air by the rotating ring. The magnet is furnished with two levers carrying movable weights, which serve to measure the power absorbed, after the manner of the Prony brake. Since in this brake the power is absorbed electrically, there is no frictional resistance, and consequently no sticking and violent vibration of the levers occur. It is also claimed that no artificial cooling is required, and that the accuracy is very much greater than that obtained with the purely mechanical form of brake.

Tandem - Compound Engine Using Superheated Steam.—A peculiar type of engine designed for use with superheated steam is described in a recent issue of the *Zeitschrift des Osterreichischen Ingenieur und Architeken Vereins*. The engine is a tandem-compound, with poppet valves operated as usual from a camshaft lying parallel with the cylinders and driven by bevel gears from the crank shaft. The rear, or high-pressure cylinder, is single-acting; steam acts only on the rear piston face. The piston is therefore constructed as a plunger piston in the high-pressure cylinder, and has an enlargement at its front end to form the low-pressure piston. The rear face of this latter piston takes steam from the receiver and exhausts it into the condenser in the usual manner; but the front face is under receiver pressure throughout the stroke, and is therefore not provided with any valves. The number of valves required with this construction is consequently only one-half those usually required; moreover, but one stuffing-box is necessary, and that one, being in the forward low-pressure cylinder head, is not exposed to the action of the high-pressure steam. All troubles incident to the maintenance of stuffing-boxes in high-pressure superheated steam are thereby avoided. Fig. 8 shows the construction of the engine. It will be noticed that there is but one set of valves for the high-pressure cylinder, and one set for the low-pressure cylinder. The admission valve in each case is on top, and the exhaust valve at the bottom of the cylinder. A closer inspection shows that the passage leading the steam from the receiver to the low-pressure cylinder connects without any intervening valve to the forward end of the latter, so that steam acts here throughout the stroke. This end acts, therefore, in a manner, as part of the receiver. A dead-beat governor controls the admission to the high pressure cylinder, and the rear end of the low-pressure cylinder exhausts to a condenser located below the engine. A by-pass to the atmosphere is provided in the exhaust pipe, to permit the engine to be run non-condensing. The condenser air-pump is driven directly from the crankpin by a pitman, which acts on a lever that works the pump rod. As will also be noticed, the same lever drives a small auxiliary feed-pump, whose action can be controlled by a valved by-pass. The engine is built by Breitfeld, Danek & Co., of Prague, Austria, under the Schmidt patents. The advantages claimed for the design are: Successful use of superheated steam at temperatures as high as 650° Fahr.; consequent high efficiency even in smaller sizes, amounting in a number of tests to 18 per cent more than that of a first-class triple-expansion engine using saturated steam; great simplicity of construction and operation; and minimum oil consumption.

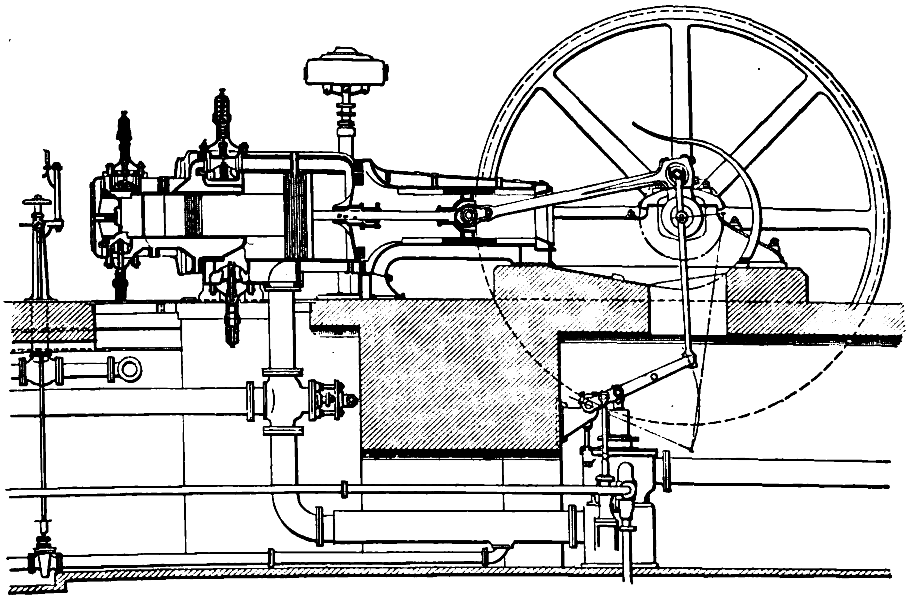


FIG. 8.—CROSS-SECTION OF THE BREITFELD-DANEK TANDEM COMPOUND ENGINE.

Automatic Speed Regulator.—*The Practical Engineer*, of London, describes a curious engine governor known as the "Equipoise" automatic speed regulator, and shown diagrammatically in Fig. 9. *A* is a rod supporting a bracket, on which is mounted a stud, *B*. A gear wheel, *C*, is loosely mounted on the stud, and meshes with a pinion, *D*, concentric with a sleeve, *E*, passing through the pinion and bracket loosely, but provided with a keyway, so that it may be rotated by the pinion, and yet be capable of sliding through it. The sleeve is provided internally with right and left-hand screw threads, which engage with two screws, *F* and *F*, the lower of which is coupled to the spindle, *G*, of a throttle valve in the chest, *H*, while the upper one is connected to the lever, *J*, which is connected with the governor. The wheel, *C*, is intermittently rotated by means of a rod, *K*, which is coupled to a suitable reciprocating part of the engine, the rod being connected to a sleeve carried by a lever, *L*, and mounted on the stud carrying the wheel, *C*. This lever has an elastic connection with a bar, *M*, provided with studs carrying pawls, *N*, each of which may engage with teeth formed on the upper face of the wheel; *C*. In order to determine the number of teeth which either of the pawls may take at any time a pallet-plate motion is employed. This, as will be seen, consists of a disc, *O*, also loosely mounted on the stud carrying the wheel, *C*, the plate being cut out for a short distance in the path of the pawls, *N*, and also provided at its rear side with bevel teeth in engagement with a bevel sector, *P*, forming part of what might be termed a three-armed lever, *Q*, pivoted on a stud carried by the bracket, *R*. One horizontal arm of this lever carries an adjustable weight, *S*, while the other is embraced by an adjustable forked rod, *T*, connected to a bracket, *U*, carried by the divided rod, *F*.

From the foregoing description it will be seen that if the engine runs beyond a given speed, the balls of the governor will fly outward, and as the central weight rises the lever, *J*, will be lifted at that end and the upper rod, *F*, and the forked rod, *T*, consequently will be depressed. The latter rocks the lever, *Q*, about its pivot, and in doing so the pallet

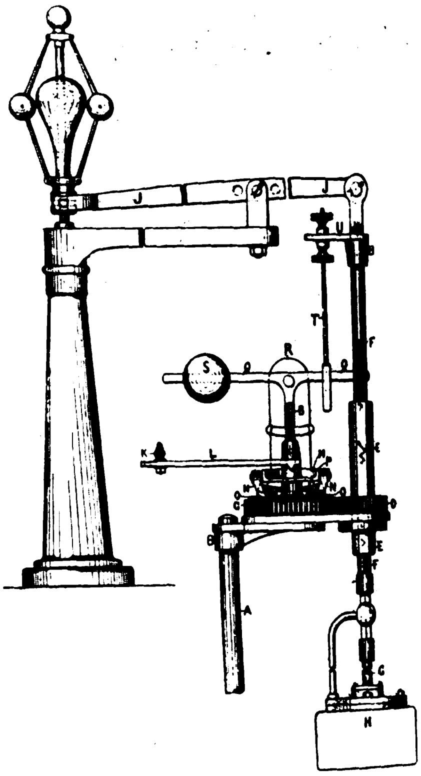


FIG. 9.—AUTOMATIC SPEED REGULATOR.

plate, *O*, is turned to the right, thus disengaging the left-hand pawl, *N*, and allowing the right-hand pawl to pass through the slotted portion of the disc, and so come in contact with the teeth on the wheel, *C*. Simultaneously, of course, the lever or disc, *M*, having a constant oscillating motion about the stud carried by it, the right-hand pawl turns the wheel, *C*, in the same direction and rotates the pinion, *D*, and the sleeve, *E*, thus separating the rods, *F* and *F*, and partly shutting off the steam from the valve, *H*, until the speed of the engine is brought back to the normal. On the other hand, when the speed is below normal, the reverse action takes place; in this case the weight, *S*, causes the lever, *Q*, to follow the forked rod, *T*, and consequently the pallet plate, *Q*, is turned in the opposite direction, so as to disengage the right-hand pawl, *M*, and engage the left-hand one with the wheel, *C*, as a result of which the rods, *F* and *F*, are drawn together and an increased volume of steam allowed to pass through the valve. It will be obvious that the action described is supplementary to the direct action of the governor balls upon the valve in the chest, *H*, and has the effect of setting the valve for each different load, so that the governor cannot see-saw or hunt.

Some Recent Electrical Patents

Portable Electric Welding Machine.—Fig. 1, herewith, illustrates a very compact form of welding transformer which has been patented by Henry E. Meyers. It consists of a shell-type transformer with a primary winding, adapted, of course, to the e.m.f. of the supply circuit, and a secondary winding consisting of heavy strap copper, the ends of which project through the side of the casing for convenience of access in the use of the apparatus. Patent No. 691,404.

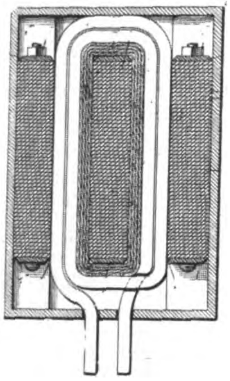


FIG. 1.—ELECTRIC WELDING MACHINE.

Armature Coils.—Every armature winder is familiar with the difficulty attendant upon making formed coils with very small wires. With a view to facilitating this class of work, Asa A. Batchelder has devised and patented the method of combining conductors illustrated in Fig. 2. This consists, broadly, of laying two or more wires side by side and binding these together with thread, or tape, or similar material, so that the result is a flat multiple conductor having a substantially rectangular outline. The manner in which such conductors will lie in an armature slot is indicated in the lower part of the engraving. Patent No. 696,398.

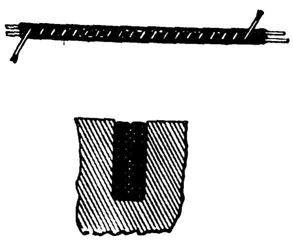


FIG. 2.—METHOD OF COMBINING CONDUCTORS.

Motor Starting Switch.—Upon starting up electric motors, especially small induction motors and those which are not equipped with finely-graduated rheostats, the trouble is frequently met that the initial rush of current through the machine will throw the circuit-breaker or blow the fuse, if such safety device be arranged with regard to the normal full-load current of the machine A means patented by Robert R. Read for avoidin this difficulty consists of a circuit-breaker adjusted for the normal full-load current and a fuse of ample carrying capacity to withstand the initial rush of current when the motor is started, in conjunction with a circuit-closing switch which first connects the motor armature to the circuit through the fuse and by further movement transfers the connection to the circuit-breaker and opens the fuse connection. This is plainly illustrated by Fig. 3, in which the dotted lines indicate the position of the switch lever for starting and the solid lines its position for running. When the switch is fully closed, as shown by the solid lines, the blade does not touch the jaws, 8, so that there is no connection between the free end of the fuse and the circuit. Patent No. 697,016.

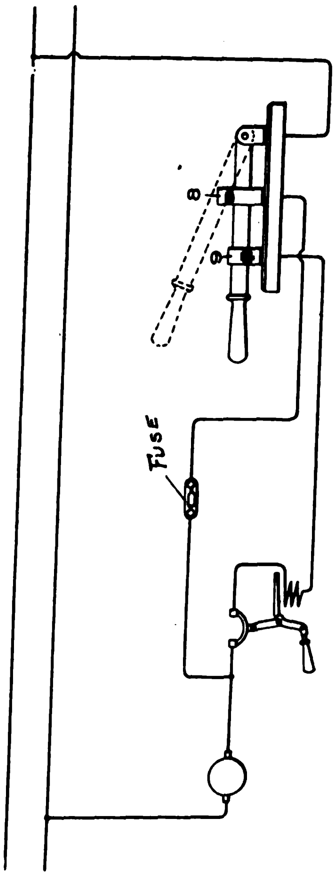


FIG. 3.—MOTOR-STARTING SWITCH.

Commutator Insulation.—A familiar trouble experienced with the ordinary form of commutator insulation, which consists almost invariably of mica, because of its good insulating qualities and its ability to resist high temperatures, is that the mica and the copper do not wear down at the same rate; so that after a considerable period of service the mica strips project slightly above the general level of the commutator segments and cause the brushes to jump and spark. A method of correcting this trouble has been patented by Edward D. Priest and George L. Schermerhorn. This consists of using strips of some soft material, such as asbestos, between two strips of mica, as indicated in the engraving, Fig. 4. The advantage of this construction, it is claimed, is that the mica may be made very thin, so that it will break off readily as soon as it projects appreciably above the commutator segments, while the asbestos, being soft, will wear away at least as rapidly as the commutator segments. Patent No. 696,488.

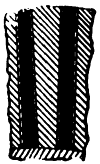


FIG. 4.

ANNUAL REPORT OF THE GENERAL ELECTRIC COMPANY.

The tenth annual report of the General Electric Company, which has just been issued, indicates a steady growth, both as to magnitude of business and prosperity, of that concern during the past four years. The report of Mr. Eugene Griffin, first vice-president of the company, shows that the sales for the year ending January 31, 1902, foot up $32,338,036, compared with $28,783,275 for the preceding year, and progressively lower figures for each of the two years anterior to 1901. The sales for the last fiscal year include about 350,000 kilowatts capacity in generators and rotary converters, over 600,000 horse-power in railway motors, 150,000 horse-power in motors for other classes of service, more than 200,000 kilowatts capacity in transformers, and over 15,000,000 incandescent lamps. The sales of generators include machines aggregating 55,000 horse-power for the Niagara Falls power houses, three of these machines being of 10,000 horse-power output each. It is interesting to note that last year's sales also include the entire equipment for the railways of Tokyo, Japan, which will require 250 car equipments, with the necessary generating and accessory parts; this will be the largest electric plant in Asia. The profits on the year's sales aggregated $7,083,914.64.

The treasurer's report shows that in addition to this profit there was realized a profit of $938,584.77 from the cash sale of stocks and bonds since the last annual report. These securities were carried on the books at $1,244,102.43, and they were sold for $2,182,687.20. This report also shows that the company has no outstanding notes payable, and that there is no paper under discount bearing the company's endorsement or guarantee; moreover, since January, 1895, the company has not borrowed any money nor has its credit been used since that date, either by issuing notes, endorsing customers' paper for discount, or lending its name in any way. This gratifying state of affairs is probably largely due to the company's policy as to terms of payment for apparatus. Mr. Griffin's report states that about 66 per cent of the total apparatus sold during the year was paid for within thirty days after the date of shipment, over 11 per cent within sixty days, 6 per cent within ninety days, and only 4 per cent on longer time than ninety days. Moreover, only one-tenth of 1 per cent of the total payments have been made in the shape of stocks and bonds.

The report of Mr. E. W. Rice, Jr., third vice-president, relating to the manufacturing and engineering department, shows that the increase in business has required extensions to existing buildings, the erection of new ones, and the provision of additional machinery to the extent of about $1,500,000, not including patterns and small tools. At the Schenectady plant the pattern shop of 52,000 sq. ft. and additions of 70,000 sq. ft. to the machine shops, which were mentioned in Mr. Rice's last report, have been completed, and the company is now erecting buildings for the manufacture of wire and cable insulating materials, which will have an aggregate of 1,800,000 sq. ft. of floor space; a machine shop for large work having 117,000 sq. ft.; a building of 60,000 sq. ft. area for increasing the facilities for manufacturing switches, controllers and similar small apparatus, and an addition of 13,000 sq. ft. for the testing department.

A new office building, which has been under construction for about a year, will soon be completed, so that the building now occupied for that purpose will be available for manufacturing purposes, and will add about 40,000 sq. ft. to the manufacturing plant. Work has also been begun on a new power house, which will add 6000 horse-power to the present equipment, and an extension of 30,000 sq. ft. to the shipping department. At the Lynn works the machine shops and testing department were expanded to the extent of 25,000 sq. ft. of floor space, and substantial additions were made to the power plant. Plans for a building of 55,000 sq. ft. floor area for the manufacture of meters and indicating instruments are now in course of preparation. The floor area of all the factory buildings is approximately 2,500,000 sq. ft., and the increase during the present year will aggregate about 400,000 sq. ft.

The erection by the British Thomson-Houston Company of large works at Rugby, England, is expected to add considerably to the company's available manufacturing facilities, as that company has heretofore been supplied chiefly from the American shops.

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NOTES.

Engine Builders' Association.—The spring convention of the Engine Builders' Association of the United States will be held May 22 and 23 at Pittsburg, Pa. The headquarters of the convention will be at Hotel Schenley, and the public reading of papers will begin at 2 o'clock on the afternoon of May 22. On the following afternoon the delegates will visit the Westinghouse Machine Company's plant. Particulars as to hotel and railway rates may be obtained from the secretary of the association, Mr. D. M. McBrier, Erie, Pa.

A Peculiar Development in the Controller Situation.—It is reported that both of the multiple-unit systems of control used by the Sprague Electric Company and the General Electric Company were anticipated in 1896 by Granville T. Woods, a negro mechanic. According to the report, Woods worked out the problem of multiple-unit control in 1896, and filed a caveat to protect his invention, patents covering which he has recently received. It is further stated that he is endeavoring to effect a settlement with the General Electric and Sprague companies for $50,000.

Water Power Development on the Pacific Coast.—The long-distance transmission companies of the Pacific slope are reaching far back in the Sierra Nevada mountain range for their water supply and utilizing water under pressures which a few years ago would have been considered impracticably high. The most recent development in this direction is an extension which has been arranged for by the Bay Counties Power Company, to consist of two water-wheels of 3700 horse-power each, to operate under an effective head of 1600 ft. and drive 2000-kw. Stanley alternators at 240 r.p.m. These water-wheels, it is said, will be the largest single tangential wheels ever installed, and will be surpassed in output only by the 5000-h. p. turbines at Niagara. The generators will be supplied with oil-tempered nickel-steel shafts made by the Bethlehem Steel Company.

High Speed Telegraphy in Railroad Service.—The Delany rapid telegraph system, which has been used to some extent by the Pennsylvania Railroad for some time past, is to be extended to Harrisburg and Pittsburg. The system has been in regular operation between Philadelphia and Altoona for six months, and there has been a regular transmission of about 500 messages a day between those cities. Railroad messages are considerably longer than ordinary commercial telegrams, so that the business done is equivalent to about 1000 ordinary messages daily. With the extension of the system to Harrisburg and Pittsburg, more business will be done per unit of time over the Delany wires than over any other single telegraph line in the world.

Typical Misinformation.—In the city of McKeesport, Pa., there has been recently considerable agitation in favor of a municipal lighting plant, and the usual flamboyant arguments have been advanced as to the vast sums of money that the city could save by operating its own equipment: The following literal quotation from a local paper indicates the character of argument which has predominated:

> At Logansport, Ind., the city charge for lighting dwellings with electricity is in no case 20 cents per light per month, and when 67 lights are used in one house the charge is $1.29 per month—or less than two cents per light per month for all-night service! and that pays enough profit to have 123 arc lights without costing the town a cent.
>
> Here is another case: Benton Harbor, Mich., has installed a city electric light plant. They had been paying $96 a year for 2000-candle-power arc lights. Now they are getting 3,000-candle-power arc lights for $24 a year! This includes every expense, direct and indirect. Will our people ever wake up?

Priority in Wireless Telegraphy.—According to a recent cable dispatch, purporting to give an extract of an article by Prof. Silvanus P. Thompson, printed in the *Saturday Review*, both the Marconi and Slaby-Arco systems of wireless telegraphy are subordinate to fundamental developments of Prof. Oliver Lodge. Prof. Thompson's article, as reported, states in part: "The Slaby-Arco system is as much a lineal descendant of Lodge's earlier work as is Marconi's. Both of them employ Lodge's methods, inasmuch as both use a coherer to relay the Hertzian waves upon a telegraphic receiver, and both employ the automatic tapper. Eliminate these features, which are due to Lodge, and both Marconi and Slaby collapse. So Marconi, who uses without acknowledgments these devices of Lodge, mouths out a denunciation of Slaby, who dares to use the same devices for the same purpose. It is a pretty quarrel. If Marconi imagines that his thin patent claims entitle him to a monopoly of the ether for the purpose of transmitting signals he is much mistaken. His dog-in-the-manger policy toward Slaby is simply silly, and the more so because neither of them can either transmit or receive a single wireless message in the United States without infringing on the patents of Lodge. It seems like the irony of fate that Lodge, the well-known principal of the University of Birmingham, after expounding the principles of wireless telegraphy in London and Oxford in 1894, should find himself pushed aside, first by the Italian, who by dint of advertising gains the public ear, and then by the German professor, and yet should actually stand master of the transatlantic situation because he holds the master patents in the United States. It is said that Lloyds has made an agreement with Marconi for fourteen years. Perhaps Lloyds is not aware where the patent rights lie. Marconi may whine as he pleases about other men snatching rewards from the scientific investigator. That is precisely what he himself has been trying to do in the last four or five years, his victim being the Englishman who was first in the field, and who, if he but knew it, is to-day master of the situation."

Without undertaking to express an opinion as to the validity of Prof. Thompson's claims for Prof. Lodge, we may say that the fact obtrusively suggests itself that both Marconi and Prof. Slaby have developed practical commercial systems, whereas Prof. Lodge has apparently done nothing.

Reception to Lord and Lady Kelvin.—On April 21 a reception was given to Lord and Lady Kelvin by the American Institute of Electrical Engineers in cooperation with Columbia University, the American Physical Society, American Association for the Advancement of Science, American Mathematical Society, Astronomical and Astrophysical Society of America and the New York Academy of Sciences. The reception was held in the gymnasium of Columbia University, both on account of the unusual facilities afforded by this building, and because the university was anxious to participate in honoring the distinguished visitors. The guests, or, perhaps more accurately speaking, the audience, began to assemble between 8:30 and 9 o'clock, and a few minutes after 9:30 Lord Kelvin arrived, and was escorted to the platform by Prof. F. B. Crocker, chairman of the committee on arrangements, Lady Kelvin being escorted to her seat by Mr. T. C. Martin, of the committee. Prof. Crocker then announced the purpose of the gathering, and after paying a handsome tribute to Lord Kelvin, introduced Dr. Nicholas Murray Butler, the newly installed president of Columbia University, who made the address of welcome on behalf of the university. Dr. Butler was particularly happy in his address, and frequently elicited vigorous applause. He said that he was proud to share with the American masters of science the honor of welcoming one of Great Britain's greatest teachers and inventors. Lord Kelvin, he said, had not only carried his investigations out to more points in the unknown than most men, living or dead, but had imparted the results of these investigations to the world at large in a manner which made it perfectly easy to understand and follow his work; a man who can explain his discoveries to others so that they can understand them must first understand them thoroughly himself. Other eulogistic addresses were delivered by Prof. Elihu Thomson on behalf of the American Institute of Electrical Engineers; Dr. Arthur Gordon Webster, vice-president of the American Physical Society, and Dr. R. S. Woodworth, past president of the American Association for the Advancement of Science, who spoke for that association and the others which participated in the reception. Lord Kelvin then responded to the various addresses, and the veneration and esteem in which he is held in this country were strikingly illustrated by the immediate rising of the entire audience as he arose and stepped to the front of the platform. Lord Kelvin spoke with a phenomenal degree of animation in view of his advanced years, and gave evidence of a remarkable clarity of memory in his references to the incidentals of the great Atlantic cable work of nearly forty years ago. He also referred to the tremendous developments that had taken place in electrical engineering since his first visit to this country, and paid high tribute to both the pioneers and the later-day engineers who were responsible for the magnificent development of the high-tension power transmission systems. At the close of Lord Kelvin's address a member of the reception committee called for three cheers for the distinguished scientist, and the immense audience rose in a body and gave these with a vigor that almost shook the entire building.

American Electrochemical Society.—The first meeting of this society, which was held April 3, 4 and 5, at Philadelphia, was a conspicuously successful one. On Thursday afternoon those in attendance paid a visit to the chemical works of Harrison Bros. & Co., in order to witness the actual operation of the Darling process for the electrolytic production of sodium and nitric acid from nitrate of soda.

The electrolytic cell consists of an iron pot, within which and extending close to the bottom is a pair of concentric cylinders of perforated iron, the annular space between the two being packed with powdered magnesia. The outer vessel forms the anode, and the carbon electrode is submerged in the fused electrolyte contained within the inner concentric cylinder. In order to prevent these cylinders from being attacked, they are in shunt connection with the anode. The drop of voltage in each cell is 15 volts. A pipe leading from a space between the cylinders and the outer vessel carries off the gases liberated, and these are condensed elsewhere and form nitric acid. The sodium floats on top of the space enclosed by the inner cylinder and at intervals is ladled out and deposited in tin cans; paraffin is first placed in the bottom of these cans, and as the sodium is added this material floats on top and protects the surface from the atmosphere.

The organization of the society was effected at a meeting held on the evening of April 3 at the Manufacturers' Club. The officers elected were: Prof. J. W. Richards, of Lehigh University, president; Chas. J. Reed, of Philadelphia, secretary; Dr. P. G. Salom, of Philadelphia, treasurer; Prof. H. S. Carhart, of Ann Arbor University, Prof. W. D. Bancroft, of Cornell University, Prof. C. A. Doremus, of the College of the City of New York, Prof. L. Kahlenberg, of the University of Wisconsin, Prof. W. R. Whitney, of Boston, Mass., and Mr. C. M. Hall, of Niagara Falls, vice-presidents. The board of director elected consists of Prof. S. P. Sadtler, Dr. E. F. Roeber and Carl Hering, of Philadelphia; C. O. Mailloux and W. D. Weaver, of New York; Dr. Samuel Sheldon, of Brooklyn; Col. Samuel Reber, U. S. A., of Washington D. C.; Edward Weston, of Waverly Park, N. J., and E. G. Acheson, of Niagara Falls.

On Friday and Saturday twenty papers were read, the titles and authors being as follows: "A University Course in Electrochemistry," by Prof. J. W. Richards; "Electrodes," by Clarence L. Collins, engineer of the Acheson Company, of Niagara Falls; "A Note on the Gladstone-Tribe Couple," by Dr. W. D. Bancroft; "The Nascent State Theory," by Chas. J. Reed; "The Electrolytic Reduction of Lead," by P. G. Salom; "The Electrolytic Refining of Composite Metals," by Titus Ulke; "A Novel Concentration Cell," by Prof. H. S. Carhart; "The Manufacture of Bisulphide of Carbon in the Electric Furnace," by Edward R. Taylor; "Current Electrochemical Theories," by Dr. Louis Kahlenberg; "A Zinc-Bromide Storage Battery," by Herbert H. Dow; "Continuous Electrolysis of Solutions of Metals," by Dr. N. S. Keith; "A Method of Electrolytic Production of Zinc from Its Ores," by Prof. Samuel S. Sadtler; "The Electrolytic Rectifier," by Prof. C. F. Burgess and Carl Hambuechen; "Caustic Alkalies and Chlorine by the Dry Electrolytic Process," by Dr. Chas. E. Acker; "The Relative Speed of the Ions in Solutions of Silver Nitrate in Pyridine and Aceto-Nitrite," by Dr. Herman Schlundt; "A New Type of Electrolytic Meter," by Dr. Konrad Norden; "The Reversible Copper Oxide Plate," by Woolsey McA. Johnson; "A Thermodynamical Note on the Theory of the Edison Accumulator," by Dr. E. F. Roeber; "Electrolysis of an Aqueous Solution by an Alternating Current," by Prof. J. W. Richards," and "The Atom of Electrochemistry," by Mr. Arvid Reuterdahl.

At the close of the last day's session the society formally recommended the adoption of the metric system. At a meeting of the council held during the convention it was decided to hold the next meeting of the society at Niagara Falls next September. Before the adjournment of the convention the number of charter members had risen to the extremely encouraging figure of three hundred and sixty-three.

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NOTICE TO ADVERTISERS.

Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

Vol. XIV. MAY, 1902. No. 5

The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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Removal.

As this issue goes to press the offices and editorial rooms of the AMERICAN ELECTRICIAN are in process of removal to the new Engineering Building, at 114-116 Liberty Street. The new building is next door to the one which we have occupied for the past three years, and affords somewhat more spacious quarters, to which our friends will always be cordially welcomed.

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Fuels.

On another page will be found an article on this subject, which we cordially commend to those who are interested in the operation of steam plants. The article does not purport to reveal any facts hitherto unknown; it presents not even a "pet theory," but it is a careful summarization of the characteristics of the various fuels, and may well be kept in a handy place for reference.

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Isolated Plant "Practice."

An analytical consideration of the equipment of the more important isolated plants of recent construction incites speculation as to whether there really is any standard of practice in the design of such plants. On one hand, one finds alternating-current equipment installed by capable engineers and including motors aggregating several hundred horse-power running intermittently and with widely varying loads; on the other hand are seen direct-current power plants the motors of which run peacefully all day long on fairly constant loads, and certainly at practically constant speeds; or perhaps direct-current plants having lamps for their chief load, with a relatively small scattering of motors. Of course, no one expects isolated or other plants to be designed in rigid accord with any code of empirical rules; there are many cases where the choice of apparatus is a complex and vexatious problem. But it is not these cases that are now under consideration. By far the larger number of isolated plants present service characteristics which indicate unmistakably the class of apparatus that is engineeringly appropriate, and it does seem that there should be some established standard of practice applicable to such plants.

In the smaller lighting plants, where there are no motors of consequence, it makes little difference whether alternating or direct-current be used; the choice depends chiefly upon the size of the plant. This is also true of plants in which continuously-running motors are used, although, aside from the first cost of the motors, the logical preference would be for alternating current, except in very small plants. For plants containing an appreciable amount of machinery operated intermittently or at various speeds and loads, such as elevators, cranes, machine tools, etc., the use of direct-current equipment is clearly and enormously preferable, unless the plant is of such huge proportions as to justify the use of rotary converters, which would take it entirely out of the class under discussion. In view of these facts, which are so well known as to render a detailed discussion of them absolutely trite, one can but wonder at the lack of uniformity in the treatment of this phase of isolated plant design.

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Steam Engine Regulation.

It is a self-evident and fully recognized fact that an absolutely uniform rate of speed at all loads cannot be obtained from an engine by means of a purely mechanical governor, inasmuch as the governor cannot act until the speed has changed. This has led to the use of electromechanical speed regulators in a few cases of engines driving generators where a very close approximation to constant speed has been desired, and has also inspired the invention and reinvention of many wildly-complicated mechanisms intended to surpass the hard-worked apparatus of the general centrifugal type. One of these latter productions, of British origin, is illustrated and described in one of our departments this month, and affords much food for thought.

For conditions under which the speed regulation afforded by the modern forms of automatic cut-off governor is insufficient, it is extremely doubtful that recourse to auxiliary "relays," or other excessive complications, will avail. The root of the difficulty is the fundamental limitation of a device that depends upon changes in speed for its operation. The next step in refinement would appear to consist of making the governor depend for its operation upon changes in load directly instead of indirectly through speed changes, which, as has been pointed out in these columns before, is not only practical when the load is electrical, but has been done with marked success. It is evidently practicable to devise an electromechanical governor which will respond to variations in load and reset the point of steam cut-off before the speed of the engine will have been affected.

An electrical form of governor, devoid of any centrifugal device, would have several advantages beyond that of quicker action. The increased sensitiveness can be obtained without involving "see-sawing" or "hunting"; such a governor may be made adaptable to all practical conditions, is susceptible of finer adjustment than the centrifugal governor, and may be easily arranged for adjustment from the switchboard of the plant. Moreover, such a governor may be made to divide the load properly between alternators and discharge other functions beyond the reach of the centrifugal governor. It would be hampered, however, by a serious disadvantage which in some cases would be prohibitive; the engine could not be run, except under throttle, unless current were being generated.

It is rather interesting to speculate upon the possibilities of an electrical governor combined with electrically-controlled valve-gear. Such a combination could be made to compensate for momentary fluctuations in load by opening the admission valves after they had been closed, within a single stroke, and angular variations during a half-revolution might thus be reduced, if not entirely eliminated. For example, if a secondary shaft were driven by the main shaft through four-to-one gears and made to open the valves through latches, clutch-cams or similar devices set and released electrically, there would be at least four points in each stroke at which the valves could be opened by the governor, and the cut-off could, of course, be made to follow the opening of the valves at intervals varying with the load requirements. With clutch-cams, the gear could be made to open the valves at almost any point of the stroke in addition to the normal opening at the beginning of it.

Like all mechanisms designed to supplant human intelligence, however, such a gear would be rather complicated and the controlling parts delicate. The failure of any one of dozens of small contacts would vitiate its effectiveness, and might easily entail wreckage. Accidental crosses between some of the various circuits would produce similar results and be almost impossible of location within a reasonable length of time. In short, the possibilities of failure are so numerous and the consequences of a failure could be so enormously disastrous in many ways that these considerations appear to overbalance the advantages that would be enjoyed from the proper operation of such an arrangement. It is a very similar case to that of the signal gongs on steam vessels. Notwithstanding the ease with which gongs may be rung electrically, the aged and crude manual pull still survives because there is too much at stake to trust to the more scientific but more delicate and vulnerable system.

Compound-Wound Motors for Railway Work

The series-wound type of motor has become so firmly established in ordinary electric railway work that it is naturally regarded as especially suitable for all electric traction. With the development of electrically-operated interurban and elevated railways, however, it becomes a moot question whether the shunt-wound machine, with series windings for starting and accelerating, is not entitled to consideration. Of course, space is precious and weight obnoxious in any traction equipment. But these considerations are of less relative magnitude in heavier equipment designed for longer runs than the usual street car. The advantages of compound-wound machines for elevated railway work are considerable, especially where there are several motors on a car and speed gradations may be obtained by series-parallel control. The series windings, being in use intermittently and for short periods, could be made of such resistance as to render exterior rheostats, "diverters," etc., unnecessary, and experience with stationary motors indicates that as the shunt fields would be constantly excited during acceleration, the flashing at controller contacts due to breaking the armature circuits would be very greatly reduced.

Then there is the time-honored claim that the motors could be made to return energy to the line on down grades, although the value of this characteristic is somewhat doubtful in view of the speed that would be involved. In order to balance the e.m.f. of the line precisely, the motors would need to run at a speed from 10 per cent to 15 per cent higher than the maximum hauling speed for which they were designed, so that the increase necessary to deliver energy to the line at an appreciable rate would be impractical in some cases and dangerous in others. But there are other advantages, such as a fairly constant maximum speed regardless of grades and loads, and those pointed out above, which are so entirely practical that we shall not be surprised to see this type of motor generally used in the near future for the classes of service mentioned.

Pole Line Construction.

One of the standing wonders of the lighter branches of the electrical industry is the policy that is responsible for the class of construction work employed by telegraph and telephone companies for country lines. Just as soon as the limits of a city of any pretensions are cleared, most of these lines degenerate into a straggling row of sickly-looking poles, set into the ground only far enough to prevent the weight of a lineman from pulling them over, and located as far apart as they can be without having the wires pull in two by their own weight or sag to a height within reach from the ground. And when a sleet comes and the wires all break, or a protracted rain or high wind topples over the poles like drunken ten pins, the public is gravely fed with platitudes such as "the company cannot control the elements." It would seem that an ordinary sense of business expediency would impel telegraph and telephone companies to make their interurban lines so substantial that they could not be wrecked by any elemental disturbance that houses and trees can withstand. The expense of repairing poorly-built lines, together with the loss of business due to wreckage, would pay handsome interest on the added investment necessary to make country pole lines reliable.

Since the recent disastrous storms in this vicinity the question of placing important trunk lines underground has been discussed at length, and the Pennsylvania Railroad Company, with characteristic progressiveness, has increased the extent of its underground system. We are inclined to doubt seriously the necessity for such an expensive policy, except as to train-dispatching lines, which cannot be made too secure against interruption. Overhead telegraph lines can be made practically invulnerable, in sections of the country where tornados and cyclones do not occur, by the application of a little hard-headed engineering to their construction. The argument that underground construction is requisite to immunity from frequent interruptions merely encourages commercial telegraph and telephone companies to perpetuate their parsimonious policy as to country lines by enabling them to quote such argument in support of any claims they may make as to the expensive and radical change necessary to improvement.

DESIGN FOR AN ELECTRIC MOTOR CYCLE.

BY J. C. BROCKSMITH.

THE BATTERY AND CONTROLLING MECHANISM.

A storage battery which may be used with good results in connection with the electric motor cycle described in the March and April numbers, consists of two seven-plate elements of the "sawed plate" or Planté type of foundation. The plates are separated by means of perforated and corrugated sheets of hard rubber and are sealed in hard rubber jars. Fig. 1 shows the details of the rubber cell, element and plates. The cells are to be 3¼ x 4½ x 7 ins. outside measurement and are to be made of stock ⅛ to 5-32 thick. At the bottom of the cell there are some ribs, preferably vulcanized in, which support the elements free from the bottom of the jar. The builder is advised to procure his jars or cells first, if the same can be obtained ready made of the size, or nearly the size, specified. He can then, if necessary, slightly modify the elements to fit his jars. The best plan is to have cells made to order to just the required dimensions, though this will be somewhat more expensive.

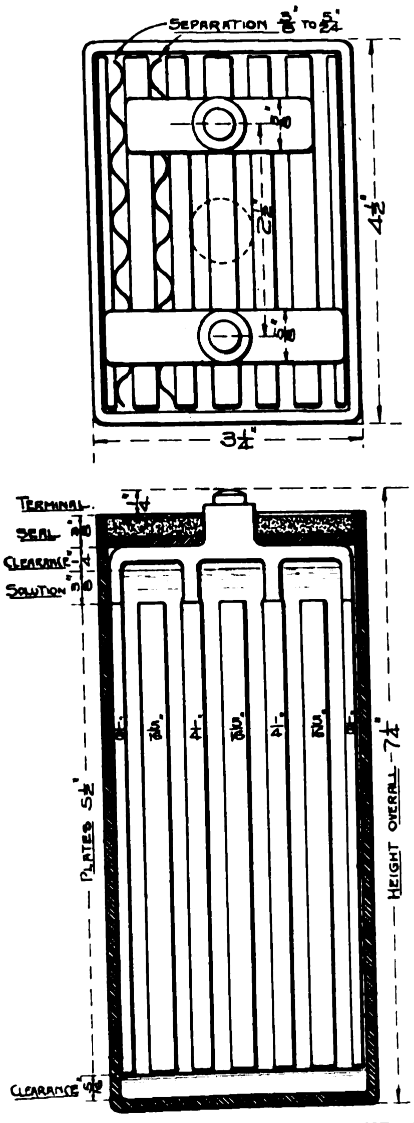


FIG. 1.—DETAILS OF CELL, ELEMENT AND PLATES.

The plates are to be cut from pure sheet lead 5-16 in. thick in case of the positives, and ¼ and ⅛ in the case of negatives. All plates are to be 4⅛ inches wide and 5½ inches in height, and are to have connecting lugs or tails provided at their tops ⅝ in. wide and ½ in. high, said lugs to be cut out one piece with the plate proper. It would appear at first sight that this latter process will result in some waste of material, but this is not the case. By cutting the plates in such manner that the lugs of adjacent plates are toward each other, the material cut away in making two plates is only a small strip ½ in. x 2⅞ ins. long. Moreover, these pieces can be remelted and used in casting the terminals of the cell, which are shown in the upper portion of the figure. In no case should the lugs be burned or soldered to the edge of the plate, as a joint so made will be constantly exposed to electrolytic action and is sure to give trouble sooner or later. One joint between a plate and the terminal of the cell is unavoidable, of course, but in the arrangement shown this is made outside the solution, where it can, if desired, be still more fully protected from corrosion by coating with acid-proof paint or some similar substance.

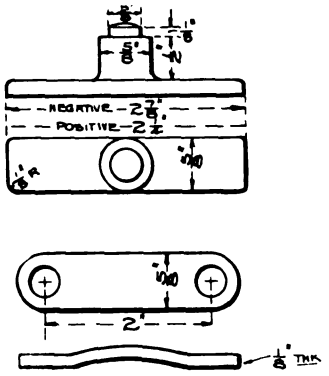


FIG. 2.—LINKS FOR PLATES.

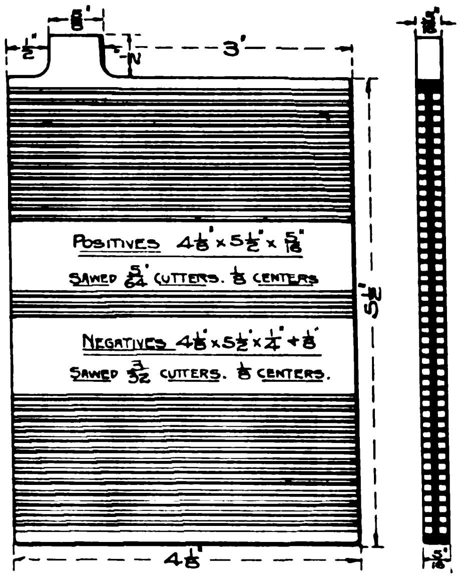

3"
Positives 4⅛"×5½"×5/16"
Sawed 5/64" cutters. ⅛ centers
Negatives 4⅛"×5½"×¼"+⅛"
Sawed 3/32 cutters. ⅛ centers.
5½"
4⅛"

FIG. 3.—DETAILS OF PLATE.

When the plates have been cut to size they are to have a number of slots cut in each face by means of metal cutting saws. The two end negatives of each element being active on one face only, are to be only one-half the thickness of the other negatives, and sawed on one side only. Inasmuch as there are some seventy plates to prepare in this manner, it will be advisable for the builder to make considerable preparation in the way of special attachments which will enable him to do the work rapidly and accurately.

A series of cutters may be mounted on a mandrel, spaced at proper intervals, and driven between centers in the lathe. The plate may be fastened upon a small table attached to the slide rest of the lathe, and adjusted for height so that the cutters will cut to the proper depth. The cutters may then be started and run across the plate by turning the feed screw. Several cuts may be necessary to complete the plate, depending on the number of cutters used. It is not necessary to use an expensive form of milling cutter for this purpose; an ordinary stamped steel cutter, known as a screw-slotting cutter, will answer the purpose equally well. In the positives the cutters should be spaced ⅛ in. between centers, the width of the slot should be 5-64 in. and its depth ⅛ in. In the negatives the cutters are to be spaced ⅛ in. between centers, the width of the cut is 3-32 in. and the depth of same 3-32 in.

Ordinarily, plates so prepared are formed by the Planté process or some modification of same, whereby the active material is formed out of the plate itself, and when formation is complete all the narrow slots in the face of the plate are filled with active material, consisting of lead peroxide on the positives and finely divided metallic lead on the negatives. Where, for any reason, it is not desired to spend the time necessary for the Planté formation, plates prepared as above described may be pasted with lead

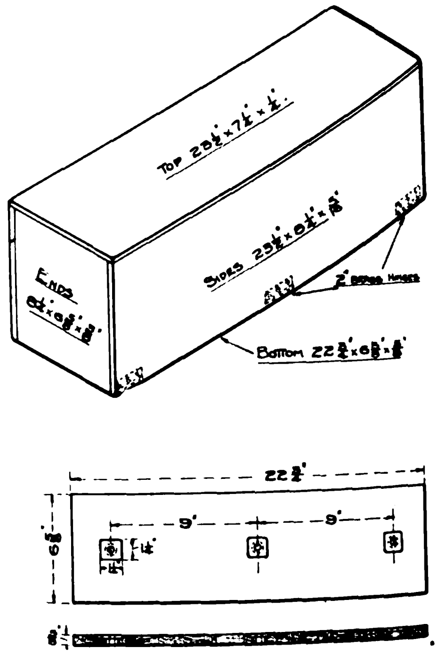


FIG. 4.—DETAILS OF BATTERY BOX.

oxide in the manner adopted for cells of the Faure type, in which case formation can be completed in a very much shorter time, and the cells thus made available for immediate use.

The plates are assembled with positive and negative plates alternating, three positives and four negatives composing an element. The connecting lugs are then soldered or burned to the cell terminals, the four negatives connecting with a crossbar on one side and the three positives with a similar bar on the other side; while this is being done the plates should be spaced at proper intervals by means of some pieces of board or slate of the proper thickness, and, finally, these can be slipped out and the regular perforated separator substituted therefor.

The complete element is now placed in the jar, and a hard-rubber cover fitted into the top of the jar and provided with a pair of holes 2½ ins. between centers large enough to allow the round cell terminals to pass through, and provided in the center with an opening through which the electrolyte can be renewed and for the escape of gases, is placed in position. Sealing compound is heated and poured in on top of the cover, rendering the cell watertight. This compound is indicated in the section of the cell, Fig. 1, as a layer about ¼ in. thick, filling the space between the cover and the top of the jar. It will be understood, of course, that the screw plug of hard rubber, or some similar device, must be provided in the center of the cover for the renewal of the electrolyte and the escape of any gases which may be evolved during charge. Such a plug is indicated in the plan view of the cell, Fig. 1, by the dotted circle ¾ in. in diameter midway between the terminals of the cell.

For connecting cells of the battery in series some links are to be made of sheet lead, ⅛ in. thick, with holes at their extremities to engage projections on the terminals of the cells. When the cells constituting the battery are finally assembled these links are to be soldered on, thus connecting the cells permanently in series. The principal data in regard to the cell here shown are as follows:

SAWED PLATE ELEMENT.

3 positives, 4⅛ x 5½ x 5-16 thick.
4 negatives, 4⅛ x 5½ x ¼ and ⅛ thick.
Surface, one side one plate, 22.75 sq. ins.
Total positive surface, 136 sq. ins., .94 sq. ft.
Space for positives, 3 × 5-16 = 15-16 ins.
Space for negatives, 3 × ¼ = ¾ ins.
Space for separators, 6 × 5-24 = 1¼ ins.
Note: Make separators 3-16 to 5-24 in.

Weight of positives, $\frac{3 \times 22.75 \times 1.22}{16} = 5.2$ lbs.
" negatives, $\frac{5.2 \times 12}{15} = 4.15$ "
" electrolyte, $1\frac{1}{4} \times 4\ 3\text{-}16 \times 6\frac{1}{2} \times .045 = 1.5$ "
" jar, estim. 1.15 "
" cell, complete, 12. lbs.

Capacity of cell, 40 ampere-hours at 15 ampere discharge rate.

The electrolyte for use in this cell is a mixture of sulphuric acid and water, both preferably pure, and having a specific gravity, when the cell is fully charged, of 1.250 to 1.275.

Fig. 4 shows the details and dimensions of the battery box. It will be understood, of course, that this size of box is suitable for containing ten cells of the size specified above. If any other size of cell be used, these dimensions will require to be modified. The box could, if necessary, be made 2 ins. longer, and also it could be made wider without altering the design of the frame; it could not, however, be made any higher without changing the frame. This box is intended to be made of some good, substantial hard wood, such as ash, walnut, or cherry. The inside of the box is to be thoroughly treated with acid-proof paint, and the outside may be finished in any manner the builder wishes. All edges should be rounded to ¼-in. radius.

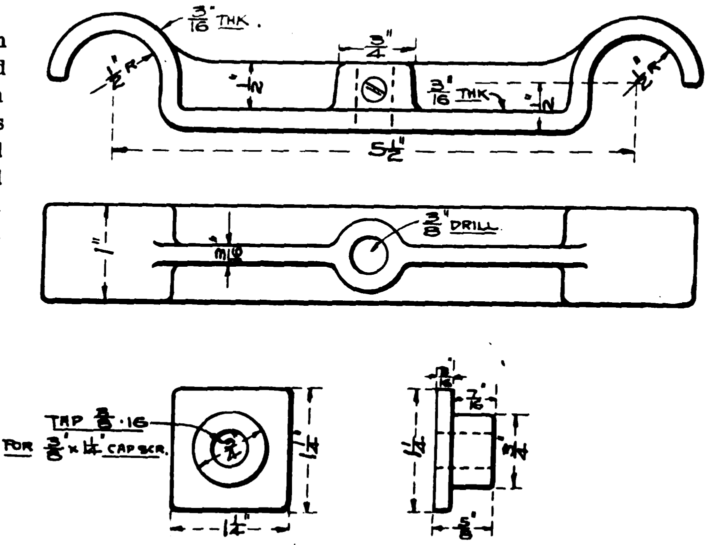


FIG. 5.—DETAILS OF FASTENINGS FOR BATTERY BOX.

As shown in the drawing, the sides of the box are hinged to the bottom of same, and arranged to swing down, thus exposing the cells for inspection. This arrangement is not absolutely necessary, however, and the box can be fastened throughout with some blued round-head wood screws. It is intended that the bottom of the box be covered with sheet felt, ⅜ to ½ in. thick, placing the jars directly upon this. In this manner the jars rest upon a yielding substance, and are consequently protected from vibrations of small amplitude, which are particularly injurious to the plates. The felt for this purpose should be of the looser and cheaper variety; a very dense felt is of no value for this work. It should be ⅜ in. thick in its natural state, without compression, this thickness having been allowed for in figuring the height of the battery compartment.

The bottom board of the battery box is shown in section in a separate detail, from which it will be noted that this part is made somewhat thicker than the rest, since it is to bear the weight of the battery, and is therefore subjected to a strain which does not fall so much on the sides or ends of the box. At three points in the bottom board there are provided some metal fastenings, countersunk below the surface, tapped for ⅜-in. cap screws, and provided with square heads to prevent same from turning. Fig. 5 shows the details of the fastenings which serve to clamp the battery box to the reach tubes. All parts shown here are intended to be cast from alzinc.

CONTROLLING MECHANISM.

The arrangement for speed control and braking in this machine is of the simplest possible description. From the nature of the case there is no reverse speed required, and the number of forward speeds has been limited to two for the sake of simplicity, the normal forward speed of 12 to 14 miles per hour, and a speed approximately half this value —6 to 7 miles per hour—are obtained by series parallel control of the battery, which is arranged in two groups of five cells in a series. If it is desired, the builder can easily make arrangements to secure a third speed, greater than the normal, by means of an "accelerator," which would be useful for spurting. The "accelerator" consists merely of a switch—it may be a single-pole, single-throw knife switch, the closing of which connects a small resistance across the series field winding, thus reducing the strength of the field and causing the motor to speed up. Such increased speed is, of course, obtained only at the expense of increased current consumption, but would be permissible if used only for short intervals of time.

Fig. 6 is a diagram of connections illustrating the series-parallel control by means of a double-pole, double-throw knife switch. This switch is preferably mounted on the top tube of the frame, within easy reach of the rider on the forward seat. The switch is to be of the kind known to the trade as a "25-ampere baby knife switch." The rider on the forward seat is, of course, the steersman, and when he is alone on the machine he will need the speed control switch directly in front of him. Where two riders are using the machine, the one in the forward seat may act as steersman, and the one in the rear seat may act as motorman, for which purpose

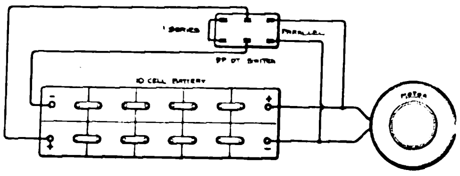


FIG. 6.—SERIES-PARALLEL CONTROL.

a second switch, the same as the first, may be wired up in parallel with the first and placed in front of the rear rider on the top tube of the frame. In this case the forward switch would be left open, and the speed changes made with the rear switch. When the switch handle is up, no current, of course, passes through the motor and the machine remains at rest. Closing the switch on the parallel side starts the machine on the slow speed; when some speed has been attained in this way the switch may be thrown over to the series position, giving the normal operating speed.

It will be seen from the diagram that the two motor terminals connect directly to two of the battery terminals, and all the battery terminals are brought up to the switch. This makes it necessary to run four wires up to the switch, but by running these alongside the frame tubes and binding them to the tubes at intervals they will not detract seriously from the appearance of the machine. All wiring should be done with No. 6 or No. 8 rubber-covered wire, and the contacts should be of the lowest resistance and most permanent description possible.

The battery which has been shown in the foregoing is what may be called a "heavy" battery, but it has some advantages in that it is not injured by high rates of charge and discharge, and therefore gives greater durability under the abuses which it is certain to receive in automobile work than does the "light" or high-capacity battery.

Taking the battery as shown, the weights of this machine foot up as follows:

Battery, 10 cells	120 lbs.
Motor, complete	40 "
Frame and wheels	40 "
Total, complete machine	200 lbs.
With one rider, weight	350 "
With two riders, weight	500 "

Now, it has been found by tests on electric vehicles that an energy consumption of 0.6 watt per pound weight of vehicle and load is required to give a speed of 12 miles per hour on hard, level road. Then, for this machine and one rider the energy would be 350 × .6 = 210 watts, or about 10½ amperes at 20 volts. For the machine and two riders it would be 500 × .6 = 300 watts, or about 15 amperes at 20 volts. This would indicate a mileage of about 25 miles with two riders and 35 to 40 miles with one rider.

It is proposed to describe at an early date a "high-capacity" battery suitable for use in this machine, which will reduce the weight of the battery equipment 30 per cent and give in addition an increase of about 30 per cent in the mileage capacity. The proposed light battery will be of the same size and outlines as the element already shown, but some special designs of plates will be introduced which result in a considerably greater output capacity than the "sawed" plates above described.

STEAM CONDENSERS.

BY CHAS. L. HUBBARD.

GENERAL PRINCIPLES.

The question of whether or not it is advisable to install a condenser in a steam plant is often one of much importance. Whether or not condensing will pay in any special case will depend upon various conditions, among which are the size and water rate of the engine, cost of injection water, and whether the exhaust steam can be used for heating purposes or not. In order to decide upon these matters intelligently one must understand the fundamental principles upon which a condenser operates; and the object of this article is to take these up in a simple manner, together with a brief description of some of the standard types of condensers now in use.

The expansion of steam in the cylinder of an engine causes its pressure to fall gradually until it finally reaches a point where it cannot be profitably used for driving the piston. At this stage some means must be provided for disposing of the steam, in order to prevent back pressure during the return stroke of the piston. If the steam is not expanded to a pressure below that of the atmosphere, it can be disposed of at once by exhausting it into the open air, but, as is well known, there is a back pressure of 14.7 pounds per square inch due to the atmosphere, so that if the exhaust steam is delivered into the open air it cannot be expanded below this pressure within the engine cylinder, to any advantage. Moreover, the air will exert a back pressure of 14.7 pounds against the piston during the exhaust stroke.

If by any means this back pressure be removed, it is evident that the engine will not only be aided by relieving the pressure upon the exhaust side of the piston, but the steam can be expanded in the cylinder far below atmospheric pressure, and more work obtained from it. The method adopted in practice for reducing the back pressure against the piston is to deliver the exhaust steam into a closed chamber and condense it by the application of cold water, which robs the steam of most of its heat. As the water of condensation has only about 1-1600 of its original volume when in the form of steam, its condensation in a closed chamber leaves part of the chamber unoccupied, and when the next delivery of exhaust steam from the engine is conducted into this empty space it will meet with a very slight opposing pressure, instead of the full atmospheric pressure. An arrangement of this kind in practical form is called a condenser. Condensers are of two general classes, surface and jet; in the first, the cooling water passes through tubes and the steam is condensed by contact with the cold tubes; in the second, the cooling water is sprayed into the same chamber with the steam and condenses it by direct contact.

In practice it is not possible to obtain a perfect vacuum for several reasons, one of which is that the cooling water is heated to a certain extent, so that it does not condense every particle of the steam; there still remains a small quantity which, however, in expanding to fill the condenser, is reduced to a low pressure. Another reason is that a small amount of air enters a jet condenser with the cooling water, and leaks into both types of condenser through faulty connections and badly-packed stuffing boxes. In order that the action of the condenser may be continuous, the flow of the cooling water through the condenser and the removal of the condensation must be continuous. To this end, pumps are used in conjunction with condensers. In the operation of the jet condenser the water that is thrown into the condensing chamber in the form of a spray to condense the steam is withdrawn, together with the condensed steam and air, by means of a single pump. In the surface condenser, the cooling water is forced through the pipes by means of a circulating pump, and a so-called air pump is provided for removing the condensed steam and air from the vacuum or condensing chamber.

The general construction of a surface condenser is shown in Fig. 1. The exhaust steam enters the top of the con-

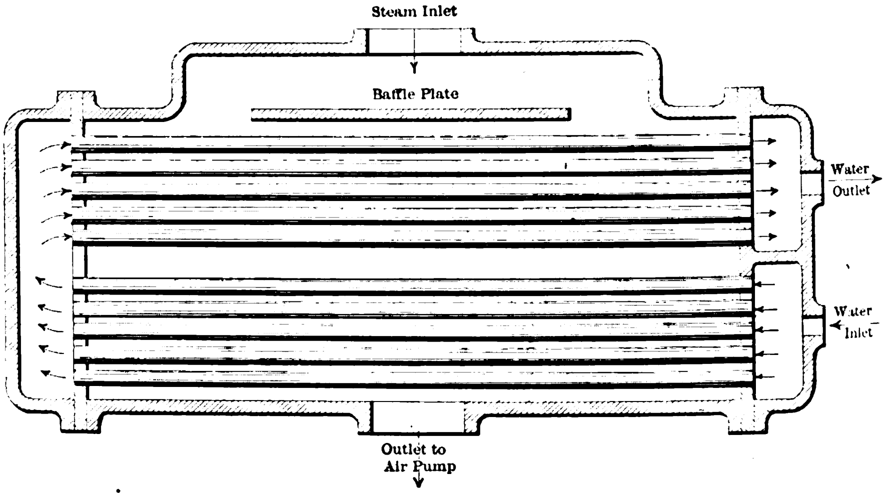


FIG. 1.—CROSS-SECTIONAL VIEW OF SURFACE CONDENSER.

densing chamber, which is filled with a large number of tubes; a baffle plate is placed just below the inlet to spread the steam and prevent its cutting the tubes; the condensed steam and air leakage are drawn off from the bottom of the chamber by the air pump. The circulation of the cold water through the tubes is indicated by the arrows. Sometimes a single pump of special pattern is used for both circulating the cooling water and removing the condensation; in such a case the steam piston is placed at the center of a long piston rod with the air-pump piston on one end and the circulating water piston on the other, as illustrated in Fig. 2. In some condensers a double tube is used in place of the single tube shown in Fig. 1; this arrangement is shown in Fig. 3. Condenser tubes are usually of solid drawn brass and generally tinned on both sides. They vary in diameter from ½ in. to 1 in., but are more commonly made ¾ in. outside diameter. Such tubes are generally secured to the tube plates by means of screwed glands and stuffing boxes packed with cotton cord or a ring of thick tape prepared especially for this purpose.

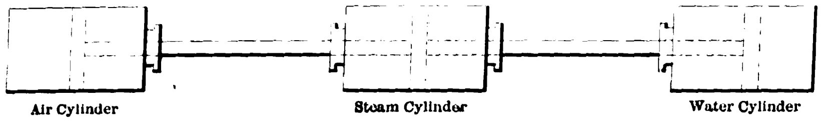


FIG. 2.—PUMP FOR CIRCULATING WATER AND REMOVING CONDENSATION.

The tube plates are usually made of brass and should be from 1.1 to 1.5 times the diameter of the tubes, in thickness, depending upon the method of packing. When the packings extend through the entire thickness of the plate the latter figure should be used, but when only partly through, as in the case of glands with tape packing, the former is sufficient. The tube plates should be secured to their seats by brass studs and nuts, or brass screw bolts. There must be no wrought iron inside of a condenser, owing to the strong corrosive action of the distilled water. When the tube plates are of large area they should be stayed to prevent danger of collapse. The holes for ferrules or glands are usually ¼ in. larger in diameter than the tubes; they are placed zigzag and their pitch may be from 1.5 to 1.7 their diameter.

The cooling surface required under any given condition may be found from the following formula:

$$S = \frac{W L}{180 (T - t)}, \text{ in which}$$

S = the required cooling surface in sq. ft. for brass tubes,

W = weight of steam to be condensed per hour,

T = temperature of the steam at condenser pressure.

t = average temperature of the circulating water,

L = the latent heat of the steam at temperature T.

The use of this formula is best illustrated by applying it to a practical example. Take the case of a 200-h.p. engine using 20 lbs. of steam per horse-power per hour, and assume the probable pressure in the condenser under average conditions to be 3 lbs. The initial temperature of circulating water may be taken at 74 degs. in summer, and its final temperature, after passing through the condenser, at 114 degs. From this data we have

$W = 200 \times 20 = 4000$ lbs. of steam per hour,

$T = 141$ degs., which is the temperature of steam at 3 lbs. pressure taken from a steam table,

$$t = \frac{74 + 114}{2} = 94 \text{ degs.}$$

$L = 1015$, latent heat of steam at 3 lbs., from steam table.

Then substituting in the formula:

$$S = \frac{4000 \times 1015}{180 (141 - 94)} = 479 \text{ sq. ft.},$$

or $479 \div 200 = 2.39$ sq. ft. per horse-power.

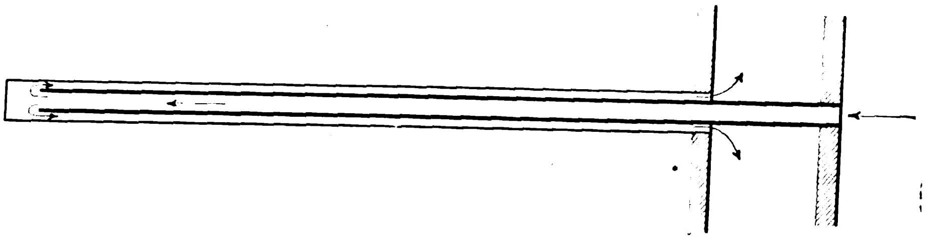


FIG. 3.—DOUBLE TUBE ARRANGEMENT FOR CONDENSER.

In marine practice it is common to make the cooling surface from 1.1 to 1.5 sq. ft. per horse-power for the best types of triple-expansion engines. This figure is lower than that found above, owing to the low steam consumption of this class of engines. A rule in more or less common use is to make the cooling surface one-half that of the heating surface of the boiler supplying the engine. This, however, gives a much larger surface than that obtained by the use of the formula. Thus, in the example just taken, suppose the boiler to be of the water-tube type, rated at 11 sq. ft. of heating surface per horse-power. The total weight of steam used by the engine was 4000 lbs. per hour; therefore, the *rated* horse-power of the boiler required to supply this amount of steam will be $4000 \div 34.5 = 115.9$, and $115.9 \times 11 = 1274.9$ sq. ft. of heating surface in the boiler. Then 637.4 sq. ft. of cooling surface would be required in the condenser by the rule of thumb given above, or $637.4 \div 200 = 3.18$ sq. ft. per horse-power, as against 2.39 by the more exact method.

The surface condenser is especially adapted to marine work, because sea water may be used for circulation through the tubes; the condensed steam being in another compartment, is not affected by this, and may be used over and over in the boilers if the oil is removed each time, and from 10 to 12 per cent of its weight of fresh water is added. Otherwise, the effect of distilled water is to corrode the boiler plates. This applies equally well to land practice when the surface condenser is used, especially where the water supply contains solid matter, salts or acids, which would be injurious to the boilers. The surface condenser is heavier and more bulky than the jet condenser for a given capacity, which is quite a strong point in favor of the jet condenser in many cases.

The general form of the jet condenser is shown in Fig. 4. In this form of apparatus the injection water, acting directly upon the steam, will produce a greater drop in pressure with a given amount of water than a surface condenser. When the condensed steam is to be used again in the boilers, however, the cooling water must be of a quality which is not injurious to the boiler plates. As shown in Fig. 4, the cooling water enters at the top of the condenser, and by means of a cone at the lower end of the water-supply pipe, is broken up into a fine spray, which mixes with the incoming steam and causes rapid condensation. The spray cone is adjustable with relation to the end of the injection pipe, and thus serves also as a valve by which the amount of water may be proportioned to that of the steam to be condensed. The injection water and condensed steam pass together through the opening at the bottom of the condensing chamber into the valve chamber of the "air" pump, and are delivered either to a convenient sewer or to a reservoir termed the "hot well," when the discharge water is used for feeding the boilers. In this type of condenser the condensing chamber is usually made from one-third to one-half the volume of the cylinder of the engine with which it is to be used.

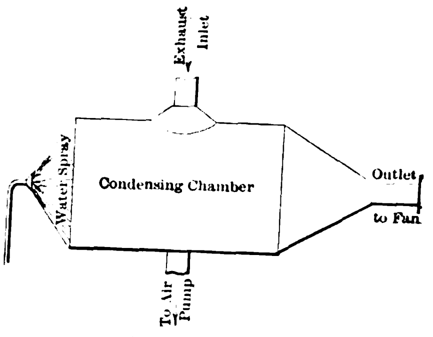


FIG. 4.— JET CONDENSER.

The injection water may be raised from a tank or other supply by the "suction" due to the vacuum in the condenser if the elevation is not greater than 20 ft.; if it is more than this, some form of pump must be used. Another form of jet condenser has a peculiar-shaped inlet, which gives a whirling motion to the water, thus forming a strong downward suction in the form of a solid stream of water, which draws the steam and air with it, and rapidly condenses the former. In this case the injection water is sometimes drawn into the condenser by suction, and sometimes pumped, depending upon the relative elevations of the different parts of the apparatus.

Another form has some of the principal features of both the jet and surface condensers. This consists of a cylindrical shell of steel or cast iron, containing a large number of tubes of small diameter. An ordinary air pump is provided for removing the condensed steam and air leakage, as in case of the ordinary surface condenser. The general arrangement of the parts is shown in Fig. 5. Exhaust steam enters the condensing chamber, as indicated. At the end of the cylinder, where the tubes are exposed to the atmosphere, is arranged a very fine spray of water, which, falling upon the ends of the tubes, is vaporized, and is readily drawn through them by means of an exhaust fan at the other end. This vapor removes the heat, which is conducted through the walls of the tubes from the steam within. The temperature of the spray need not necessarily be low, as the heat from the steam is absorbed largely by the evaporation of the spray.

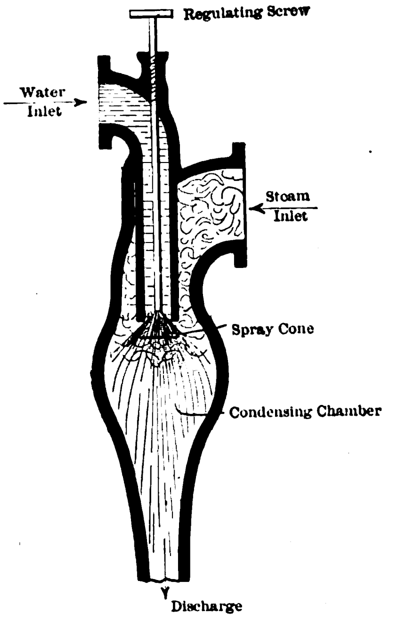


FIG. 5.—MODIFIED JET CONDENSER.

In using any form of condenser it should be by-passed, so that the steam can be exhausted outboard in case of a break-down or repairs. The condenser may be placed upon the same level with the engine, or above it if desired, without affecting its operation. In case of the latter arrangement, the exhaust main should be dripped at the bottom.

EVAPORATION IN STEAM BOILERS.

Next to the indispensable table of the physical properties of steam, probably the most useful steam table is one of the factors of evaporation. As most readers of the AMERICAN ELECTRICIAN undoubtedly know, the "factor of evaporation" is the number by which to multiply the quantity of water actually evaporated by a boiler in order to ascertain how much water would be evaporated by the boiler under the same firing conditions, but with the boiler open to the atmosphere so as to reduce the pressure to 0 by gauge, or 14.7 lbs. absolute, and with feed-water delivered to the boiler at 212° Fahr. In other words, to ascertain the unrestricted evaporative ability of the boiler. This is the accepted basis of boiler rating and of comparison between different boilers, and is commonly termed the "evaporation from and at 212°." The basis of commercial rating is the evaporation of 34½ lbs. of water per hour per horse-power, from and at 212°.

There have been computed and published several tables of evaporation factors, all based on essentially the same formula, of course. This formula is usually written:

$$\frac{H - h}{965.7} = F \quad \ldots\ldots \; (1)$$

in which *H* represents the total heat (above 32°) in a pound of steam at the pressure carried in the boiler; *h*, the heat units required to raise a pound of water from 32° to the temperature of the feed-water, and *F* the factor of evaporation. The difference represented by *H* — *h* is the number of heat units added to the feed water in order to increase its temperature to the boiling point, and then evaporate it. Dividing this by 965.7, which is the number of heat units required to evaporate a pound of water at 212°, obviously gives the number of pounds that would be evaporated at that temperature by the same number of heat units that have been applied to the water in the boiler.

A table of evaporation factors is given herewith which differs from others of this character in that it has been computed for even gauge pressures instead of absolute pressures, and the steam pressures and feed-water temperatures are given chiefly in steps of 5 in order to make the table compact and facilitate pasting it in a data book of a size that can be carried in the pocket. The use of gauge pressures instead of absolute pressures does not cause the evaporation factors to vary materially from those in tables computed from absolute pressures, only the fourth decimal being affected. But for everyday practical work it is more convenient to deal only with gauge pressures, and less likely to cause errors due to the hasty reading of head-line figures.

The application of the table to boiler tests may be illustrated by an example. Suppose that a horizontal tubular boiler operated under test evaporates 3295 lbs. of water an hour; during the test the steam pressure is maintained at 95 lbs. and the feed-water is delivered to the boiler at 204°. What is the horse-power developed? Referring to the table, in the 95-lb. column and opposite the feed-water temperature of 204° is found the evaporation factor 1.047, and multiplying this by the water evaporated gives 1.047 × 3295 = 3449.867, or practically 3449.9, as the quantity of water that would be evaporated from and at 212° by the application of the same amount of heat. As the evaporation of 34½ lbs. of water per hour from and at 212° constitutes one horse-power, this boiler will have been developing 3449.9 ÷ 34½ = practically 100 horse-power, according to the commercial basis of rating.

The usefulness of a table of evaporation factors is not limited to ascertaining the ability of a boiler to evaporate water from and at 212°. These factors also show the saving obtainable by heating the feed-water. As explained above, the expression *H* — *h* represents the number of heat units that have been added to the water in order to bring it up to the temperature of the steam and then evaporate it against the pressure of the steam. Consequently, the relation between the heat required to evaporate water fed in at a temperature *t*, and that required for water fed at a temperature *t'*, the steam pressure being the same, will be given by the fraction

$$\frac{H - h}{H - h'},$$

in which *h* and *h'* represent the heat units in the feed-water at the temperatures *t* and *t'* respectively. As this is a ratio, dividing each term by 965.7 or any other number will not affect its value, so that the evaporation factor, $F = \frac{H - h}{965.7}$, may be substituted for *H* — *h*, and the factor $F' = \frac{H - h'}{965.7}$, for *H* — *h'*; thus:

$$\frac{E}{F} = R,$$

R being the ratio between the heat (and consequently fuel) required with a feed temperature *t*, and that required with a feed temperature *t'*, to produce steam of a given pressure. A convenient derivation from this formula is

$$\frac{C\ F'}{F} = C' \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which *C* is the coal burned per pound of water evaporated, when the evaporation factor is *F*, and *C'* is the amount that would be burned if the evaporation factor were *F'*.

For example, a boiler operated at a gauge pressure of 120 lbs., with feed-water at 195°, shows a fuel consumption of 0.125 lb. per pound of water evaporated; what would be the fuel rate with feed-water at 208°?

The factor for 120 lbs. and 195° is 1.0613; and that for 120 lbs. and 208° is 1.0477;

FACTORS OF EVAPORATION.

Temp. of Feed.	Boiler Gauge Pressure; Pounds Per Square Inch.																		Temp. of Feed.
	60	65	70	75	80	85	90	95	100	105	110	115	120	125	130	135	140	150	160	
50	1.1987	1.2002	1.2016	1.2028	1.2040	1.2051	1.2062	1.2073	1.2082	1.2093	1.2103	1.2113	1.2122	1.2131	1.214	1.2148	1.2156	1.2171	1.2186	50
55	1.1935	1.1949	1.1963	1.1976	1.1988	1.1999	1.2010	1.2021	1.2032	1.2042	1.2052	1.2061	1.207	1.2079	1.2088	1.2097	1.2105	1.212	1.2135	55
60	1.1884	1.1898	1.1911	1.1924	1.1936	1.1948	1.1959	1.197	1.198	1.199	1.2	1.2009	1.2018	1.2027	1.2036	1.2044	1.2052	1.2068	1.2083	60
65	1.1832	1.1846	1.1859	1.1872	1.1884	1.1896	1.1907	1.1918	1.1928	1.1938	1.1948	1.1957	1.1966	1.1975	1.1984	1.1993	1.2001	1.2016	1.2031	65
70	1.178	1.1794	1.1807	1.182	1.1832	1.1844	1.1855	1.1866	1.1876	1.1886	1.1896	1.1906	1.1915	1.1924	1.1933	1.1941	1.1949	1.1964	1.1979	70
75	1.1728	1.1742	1.1755	1.1768	1.1780	1.1792	1.1803	1.1814	1.1824	1.1834	1.1844	1.1853	1.1862	1.1871	1.188	1.1889	1.1897	1.1912	1.1927	75
80	1.1676	1.169	1.1703	1.1716	1.1728	1.174	1.1751	1.1762	1.1772	1.1782	1.1792	1.1802	1.1811	1.182	1.1829	1.1837	1.1845	1.1860	1.1875	80
85	1.1624	1.1638	1.1652	1.1665	1.1677	1.1688	1.1699	1.171	1.172	1.1730	1.174	1.175	1.1759	1.1768	1.1777	1.1785	1.1793	1.1809	1.1824	85
90	1.1572	1.1586	1.16	1.1613	1.1625	1.1636	1.1647	1.1658	1.1669	1.1679	1.1689	1.1698	1.1707	1.1716	1.1725	1.1733	1.1741	1.1757	1.1772	90
95	1.152	1.1534	1.1548	1.1561	1.1573	1.1584	1.1595	1.1606	1.1617	1.1627	1.1637	1.1646	1.1655	1.1664	1.1673	1.1681	1.1689	1.1705	1.172	95
100	1.1469	1.1483	1.1496	1.1509	1.1521	1.1533	1.1544	1.1555	1.1565	1.1575	1.1585	1.1594	1.1603	1.1612	1.1621	1.1629	1.1637	1.1653	1.1668	100
105	1.1417	1.1431	1.1444	1.1457	1.1469	1.1481	1.1492	1.1503	1.1513	1.1523	1.1533	1.1542	1.1551	1.156	1.1569	1.1578	1.1586	1.1601	1.1616	105
110	1.1365	1.1379	1.1392	1.1405	1.1417	1.1429	1.144	1.1451	1.1461	1.1471	1.1481	1.149	1.1499	1.1508	1.1517	1.1526	1.1534	1.1549	1.1564	110
115	1.1313	1.1327	1.134	1.1353	1.1365	1.1377	1.1388	1.1399	1.1409	1.1419	1.1429	1.1438	1.1447	1.1456	1.1465	1.1473	1.1481	1.1496	1.1512	115
120	1.1261	1.1275	1.1288	1.1301	1.1313	1.1825	1.1336	1.1347	1.1357	1.1367	1.1377	1.1386	1.1395	1.1404	1.1413	1.1422	1.143	1.1445	1.146	120
125	1.1209	1.1223	1.1236	1.1249	1.1261	1.1273	1.1284	1.1295	1.1305	1.1315	1.1325	1.1334	1.1343	1.1352	1.1361	1.1370	1.1378	1.1393	1.1408	125
130	1.1157	1.1171	1.1184	1.1197	1.1209	1.1221	1.1232	1.1243	1.1253	1.1263	1.1273	1.1282	1.1291	1.1300	1.1309	1.1318	1.1326	1.1341	1.1356	130
135	1.1105	1.1119	1.1132	1.1145	1.1157	1.1169	1.118	1.1191	1.1201	1.1211	1.1221	1.123	1.1239	1.1248	1.1257	1.1266	1.1274	1.1289	1.1304	135
140	1.1052	1.1066	1.108	1.1093	1.1105	1.1117	1.1128	1.1139	1.1149	1.1159	1.1169	1.1178	1.1187	1.1196	1.1205	1.1214	1.1222	1.1237	1.1252	140
145	1.1	1.1014	1.1028	1.1041	1.1053	1.1065	1.1076	1.1087	1.1097	1.1107	1.1117	1.1126	1.1135	1.1144	1.1153	1.1161	1.1169	1.1185	1.12	145
150	1.0948	1.0962	1.0976	1.0988	1.1	1.1012	1.1024	1.1035	1.1045	1.1055	1.1065	1.1074	1.1083	1.1092	1.1101	1.1109	1.1117	1.1133	1.1148	150
155	1.0896	1.091	1.0924	1.0936	1.0948	1.096	1.0971	1.0982	1.0992	1.1002	1.1012	1.1022	1.1031	1.104	1.1049	1.1057	1.1065	1.1081	1.1096	155
160	1.0844	1.0858	1.0872	1.0884	1.0896	1.0908	1.0919	1.093	1.094	1.0951	1.096	1.097	1.0979	1.0988	1.0996	1.1005	1.1013	1.1029	1.1044	160
165	1.0792	1.0806	1.0819	1.0832	1.0844	1.0856	1.0867	1.0878	1.0888	1.0898	1.0908	1.0918	1.0927	1.0936	1.0945	1.0953	1.0961	1.0977	1.0992	165
170	1.074	1.0754	1.0767	1.078	1.0792	1.0804	1.0815	1.0826	1.0836	1.0846	1.0856	1.0865	1.0874	1.0883	1.0892	1.0901	1.0909	1.0924	1.094	170
175	1.0687	1.0701	1.0715	1.0728	1.074	1.0752	1.0763	1.0774	1.0784	1.0794	1.0804	1.0813	1.0822	1.0831	1.084	1.0848	1.0856	1.0872	1.0888	175
180	1.0635	1.0649	1.0663	1.0675	1.0687	1.0699	1.071	1.0721	1.0732	1.0742	1.0752	1.0761	1.077	1.0779	1.0788	1.0796	1.0804	1.082	1.0836	180
185	1.0583	1.0597	1.061	1.0623	1.0635	1.0647	1.0658	1.0669	1.0679	1.0689	1.0699	1.0709	1.0718	1.0727	1.0736	1.0744	1.0752	1.0768	1.0783	185
190	1.053	1.0544	1.0558	1.0571	1.0583	1.0595	1.0606	1.0617	1.0627	1.0637	1.0647	1.0656	1.066	1.0674	1.0683	1.0692	1.07	1.0716	1.0731	190
195	1.0478	1.0492	1.0506	1.0519	1.0531	1.0542	1.0553	1.0564	1.0575	1.0585	1.0595	1.0604	1.0613	1.0622	1.0631	1.0639	1.0647	1.0663	1.0679	195
200	1.0426	1.044	1.0453	1.0466	1.0478	1.049	1.0501	1.0512	1.0522	1.0532	1.0542	1.0552	1.0561	1.057	1.0579	1.0587	1.0595	1.0611	1.0626	200
202	1.0405	1.0419	1.0432	1.0445	1.0457	1.0469	1.048	1.0491	1.0501	1.0511	1.0521	1.0531	1.054	1.0549	1.0558	1.0566	1.0574	1.0590	1.0605	202
204	1.0384	1.0398	1.0411	1.0424	1.0436	1.0448	1.0459	1.047	1.048	1.049	1.05	1.051	1.0519	1.0528	1.0537	1.0545	1.0553	1.0569	1.0584	204
206	1.0363	1.0377	1.039	1.0403	1.0415	1.0427	1.0438	1.0449	1.0459	1.0469	1.0479	1.0489	1.0498	1.0507	1.0516	1.0524	1.0532	1.0548	1.0563	206
208	1.0342	1.0356	1.0369	1.0382	1.0394	1.0406	1.0417	1.0428	1.0438	1.0448	1.0458	1.0468	1.0477	1.0486	1.0495	1.0503	1.0511	1.0527	1.0543	208
210	1.0321	1.0335	1.0348	1.0361	1.0373	1.0385	1.0396	1.0407	1.0417	1.0427	1.0437	1.0447	1.0456	1.0465	1.0474	1.0482	1.049	1.0506	1.0522	210
212	1.03	1.0314	1.0327	1.0340	1.0352	1.0364	1.0375	1.0386	1.0396	1.0406	1.0416	1.0426	1.0435	1.0444	1.0453	1.0461	1.0469	1.0485	1.0501	212

substituting these and the figure for coal consumption in formula 2 above:

$$\frac{.125 \times 1.0477}{1.0613} = 0.1234 \text{ lb.},$$

which is the amount of coal per pound of water that would be required, provided all conditions were precisely alike except the feed-water temperature.

The table not only serves to show the advantage to be gained by heating the feed-water, but it also serves to show the relation between the fuel required at one steam pressure and that required at some other steam pressure, with the same feed temperature; also to make comparison between any combinations of feed temperature and steam pressure. One must be careful, however, in substituting values in formula 2, to always put the present or assumed evaporation factor in the denominator and the factor corresponding to proposed conditions in the numerator, the known or assumed fuel rate being in the numerator and the rate corresponding to F' being unknown.

Interesting approximate comparisons may be made without any computation. For example, the evaporation factor corresponding to 90 lbs. pressure and 190° feed temperature is 1.0606; the factor for 160 lbs. and 202° is 1.0605, or practically the same. This indicates that a boiler steaming at 90 lbs. with feed at 190° could be carried up to 160 lbs. pressure with the same coal consumption by increasing the feed temperature to 202°, provided the boiler would stand the pressure. This is not precisely true, because at the higher steam and water temperatures there would be less difference between the temperature of the fire and that of the water in the boiler, so that less heat would be transferred per unit of time. As the temperature of the fire is enormous, however, the correction for the decreased rate of heat transference would be relatively small, the order of magnitude being 1 per cent to 2 per cent.

Reckoning the other way around, the amount of water that can be evaporated into steam under different combinations of feed temperatures may be ascertained by means of the formula

$$\frac{F\,W}{F'} = W' \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

in which W is the water evaporated when the factor is F, and W' is the quantity which would be evaporated if the factor were F'.

◆

An Opposition Wireless Telegraph Station.—It is stated that the American Wireless Telegraph & Telephone Company is constructing a tower at the Highlands of Navesink, with the intention of reporting incoming vessels in opposition to the Marconi Company. The tower will be 130 ft. high, and will have a base 40 ft. square. This location is the highest point on the Atlantic coast south of Maine, being 210 ft. above the sea level. Pilot boats will stand out to sea and report by wireless telegraphy the names of the incoming vessels.

RAILWAY MOTOR SUSPENSION AND LOOSE MESHING OF GEARS.

BY FRANK BERRY, JR.

The way in which a street railway motor is suspended has a great deal to do with its operation. In suspending a motor to any form of truck, the first precaution to be taken into consideration is to have the motor rigidly bolted to a suspension-bar having enough cross-section to sustain the motor under the most severe conditions without bending; the next precaution is to have the motor hung high enough to clear any obstacle which may lay between the track rails. Moreover, if a motor is not firmly secured to the suspension-bar with bolts of suitable diameter, which will, of course, depend upon the weight of the motor, the pounding over switches and frogs will very soon loosen the bolts and the subsequent play of the motor may spring the suspension-bar, involving the danger of dropping the motor.

The hanging of a railway motor as to the height above the tracks will depend upon the size of the motor and the diameter of the car wheels, but under no conditions should a motor be run hanging so low as to hit raised stones which may have worked up from the road-bed, without being protected by a plow-board arranged so as to throw off any obstacle which will not pass under the motors.

It frequently happens when a light suspension-bar is used that the bar will bend, or the bolts work loose, throwing the motor out of line and pulling the pinion away from the gear. Now, the gears and pinions used on most railway equipments are of the involute type, and as the teeth taper near the edge, pulling the pinion away from the gear will cause the two to mesh very loosely, and upon starting the motors rattling and grinding are produced, which decrease the life of the pinion and gear; instead of the wear being equally distributed along the entire length of the teeth, as it should be, it all comes on the tips, with the result that the teeth are all knife-edged and the pinion is only fit for scrap metal after a moderate period of service that should leave it in fairly good condition.

In some cases the loose meshing of gears is due to hanging a heavier motor on the same truck without using a heavier suspension-bar.

To ward off trouble of this kind, all motors and trucks should be frequently gone over, with a view to making sure that no suspension-bars are bent, all the bolts are set tight and no cotter pins are missing. When a car is run in with a suspension-bar sprung by overweight, instead of taking it out, straightening it and putting it back, if a heavier bar were substituted it would mean a great saving in pinions and gears in the course of a year's time.

THE CONSTANT-CURRENT TRANSFORMER.

BY A. S. M'ALLISTER.

The operation of low-voltage arc lamps in parallel on a constant-potential system necessitates a prohibitive expenditure for conducting material when the area to be lighted is extensive and the lamps widely separated. For such service it is common practice to run lamps in series with constant current. With the adoption of alternating currents for central station generation of electrical energy there has been developed a field for some means of transforming the constant potential at the alternators to constant current for the operation of series arc lamps. As a method of immediately applying alternating currents to existing systems, alternating-current motors, of either the induction or the synchronous type, driving arc light generators, was a logical development.

Where only high-voltage alternating currents are available this method requires the use of step-down transformers, a motor and a generator, each carrying the full load. When the pressure at hand is sufficiently low, step-down transformers may be dispensed with, but a double equipment is still necessary. The last few years have witnessed the development of a new type of apparatus which converts directly the alternating current at a constant potential of any value to a constant current, with a voltage varying with the load. These constant-current transformers depend for their regulation upon the magnetic leakage between the primary and secondary coils.

In a previous article it was shown that with constant impressed pressure upon a given coil of negligible impedance the magnetism within the coil must have a constant value at all loads. It was also shown that, having a certain coil surrounding an alternating magnetic field, the e.m.f. generated in the coil depends upon the strength of field. If, therefore, the field which the secondary surrounds be varied, the e.m.f. generated in the secondary will be varied in precise proportion.

From physics is obtained the law that currents which are parallel and which flow in opposite directions repel one another. That in any transformer the current in the secondary flows in opposite direction to a component of the primary current has been stated previously. In the ordinary constant-potential transformer this repelling action between such currents is prevented from producing motion of the coils by the mechanical construction. In the Thomson constant-current transformer, however, this action is utilized to adjust the relative position of the primary and secondary coils. When the coils are widely separated the paths for leakage lines are increased and the lines which the secondary surrounds are less than when the coils are quite near each other.

These transformers are most conveniently immersed in oil for insulation, lubrication and cooling purposes. Their efficiency is fair at all loads except the very lowest, but their power factor, which is determined by the magnetic leakage, is necessarily low at all loads, ranging, in general, from 25 per cent at one-quarter load to 80 per cent at full load.

STORAGE BATTERIES IN SMALL STATIONS.

In small villages and towns of from five hundred to five thousand inhabitants, it has been usually found unprofitable for a station to furnish current throughout the twenty-four hours of the day, owing to the small day load, for which alone the running of the engine and generator would not be warranted. Such was the condition of affairs at Milan, Mich., until recently. The lighting plant was located near the center of distribution, in a building which contained also a saw-mill, a grist-mill and a machine shop, all owned and operated by the same person. Power was obtained for carrying on these various industries from a 60 and a 120 horse-power engine, both running non-condensing, and the latter being belted to a counter-shaft from which the various machines required for the mills mentioned were operated. The smaller engine was used for driving the electric generators. The boiler, which furnished the steam for both of the engines, was fed on refuse and scrap material from the mills, supplemented by coal when necessary. Fig. 1 is a view of the engine room, the engine in the foreground being the one operating the electric plant. The electric plant consisted of two 125-volt generators, one of 20-k.w. capacity and the other of 25-k.w. capacity, which were run on the Edison three-wire system, with 220 volts between the outer wires. The center of the load was located within 100 yards of the plant, and the longest feeder did not extend more than 100 yards beyond that center. The dotted curve in Fig. 1 shows the load carried by the plant at that time. The maximum load of 150 amperes was reached at about 6.30 in the evening, and continued from that time until about 8 p. m., after which it gradually decreased

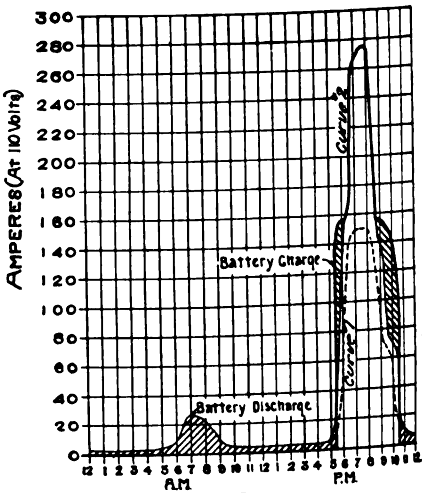


FIG. 1.—LOAD AND STORAGE BATTERY CURVES.

until 11 p. m., when it amounted to only ten amperes, remaining practically constant at that load until midnight, when the plant was shut down.

At that time current was used exclusively for lighting purposes, and that only by storekeepers. When the village council had decided to light the streets of the village by electricity, it was found that provision for street lighting would entail an expenditure for copper, poles, etc., such as was not warranted by the returns offered from street lighting alone. It was found, however, that residences along the lines would use electricity for lighting purposes, provided they would be furnished power during the day also. After a careful study of the conditions, and a thorough investigation of the different methods of meeting the same, as well as providing for future requirements, it was decided to install a storage battery to carry the late night and day load, and thus provide for maintaining a twenty-four hour service. In accordance with this decision, a battery of chloride accumulators was installed. This battery consists of fifty-six type 15-E elements in glass jars, with a total capacity of 30 k.w. hours at the eight-hour rate of discharge.

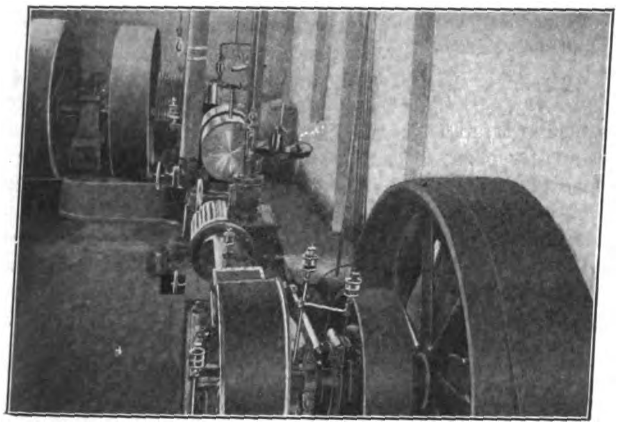


FIG. 2.—VIEW IN ENGINE ROOM.

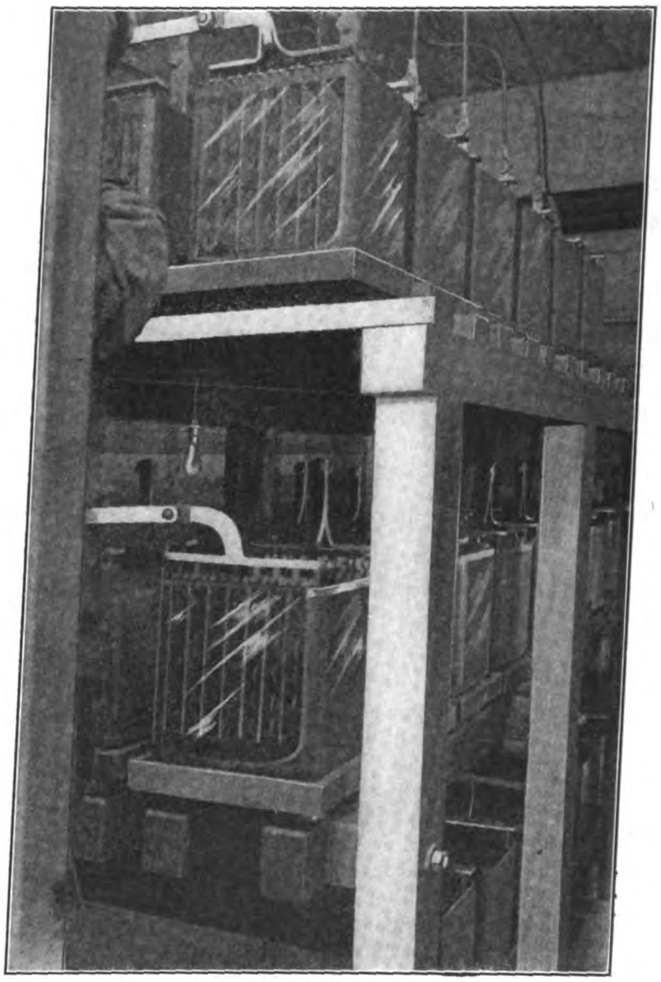


FIG. 4.—ARRANGEMENT OF STORAGE BATTERIES.

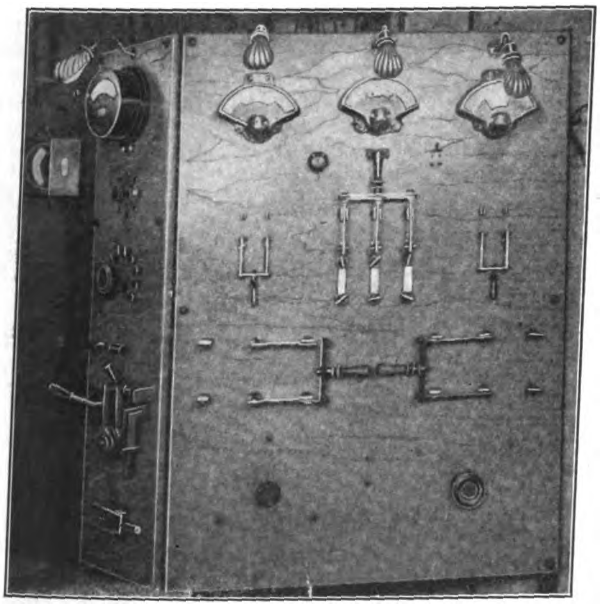


FIG. 3.—SWITCHBOARD.

It is located, as shown by Fig. 4, on a 3-tier rack in a room 8 ft. x 12 ft. x 10 ft. high adjoining the dynamo room in the mill. As the battery is only required for discharging at light loads, the two outer wires of the 3-wire system are arranged so as to be connected together at such time, thus converting the system while fed by the battery into a 2-wire system. It is, however, planned that when the load increases sufficiently to warrant an increase in battery investment, a second similar battery will be installed, and thereafter one battery used on each side of the three-wire system. Fig. 3 gives a view of the switchboard.

The system of wiring mains was extended by running feeders in several directions a distance of two-thirds of a mile from the station, and a contract was entered into with the village under which enclosed arc lamps were furnished for street lighting. In addition, a large number of residences were equipped with electric lights, and some ventilating fan motors were installed in a school and in stores. The total increase of load at the station on account of the additional service amounted to the equivalent of the full load previously carried, as can be noted by comparison between the dotted curve in Fig. 1 showing the former winter load, and the solid curve which shows the load on February 24, 1902, after the battery was installed. Left-hand cross-hatching, it will be noted, represents battery discharge, and right-hand cross-hatching, battery charge.

The time and amount of battery charge and discharge and hours of operation of the machinery are also shown by curve 2, these being according to the usual method of operation of this plant, as the generators are started each evening at dusk; one generator being connected directly to the battery for charging it, and the other furnishing the current required for the system, to which it is connected on the simple 2-wire plan. When the lighting load increases to about 150 amperes, the battery is disconnected from its charging generator, and both machines are used to furnish power to the system, which is then operated on the 3-wire plan, the battery being allowed to rest until after the peak of the evening load, when the lighting load has decreased sufficiently to again permit converting the system from 3-wire to 2-wire. The current required on the system is then supplied from one generator, the other generator being again used to charge the battery until shutting-down time, which is generally about 10 p. m. From that time, the battery carries the entire load until dusk the next evening, with the exception of occasional days when the day load is excessive, when the generators are run for a short time to carry such load until it decreases to the normal amount.

The evening consumption of current is now two-thirds greater than it previously was, and the day load added is equivalent to about one-third more, thus doubling the total load. The total fuel consumption, however, has only increased about 25 per cent, indicating that the cost of fuel per k.w. hour of current delivered from the switchboard to the system has been decreased about 37½ per cent. This decrease is principally due to the fact that the engine while in operation is always under full load and works much more economically than before the battery was installed.

Lessons in Practical Electricity

THE DYNAMO; CONDUCTORS MOVED CIRCULARLY IN A MAGNETIC FIELD.

The dynamo-electric machine, or dynamo, as it is usually termed for brevity, embodies all of the principles explained in the eight preceding lessons. An e.m.f. is induced by causing wires to cut magnetic lines of force, which are supplied from a large electromagnet, and the induced e.m.f. is applied to circuits through which current is forced in accordance with the laws stated several months ago.

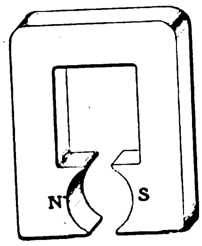


FIG. 1.

If an electromagnet be provided with pole-pieces of the shape indicated in Fig. 1, instead of the ordinary flat poles, and a loop of wire be arranged as in Fig. 2, so that it can be revolved about an axis corresponding to the center of the circular chamber between the magnet poles, spinning the loop about its axis will cause an e.m.f. to be induced in it which will vary in value and direction during each revolution; and, if the loop be closed to form a complete circuit, as it is shown here, the e.m.f. will force through the wire a current, the strength and direction of which will vary with those of the e.m.f. Suppose the loop to be revolved clockwise; while the "active" stretches *a* and *b* are midway between the poles, as in Fig. 2, no e.m.f. will be generated, because the wires can move an appreciable distance without cutting any lines of force. As the wires *a* and *b* approach the edges of the magnet poles *S* and *N*, respectively, they commence to cut the magnetic lines which are passing across from pole to pole, and a feeble e.m.f. is induced in each wire. As the wires progress, their course gradually approaches more and more to a right angle with the direction of the magnetic lines, until they reach a point opposite the pole centers, as in Fig. 3. Then they cut the lines precisely at right angles, and the rate of cutting is consequently greatest, so that the e.m.f. induced is greatest at this instant. Further progress reduces the rate of cutting, because the angle of cutting becomes more and more gradual; consequently, when the loop passes from the position of Fig. 3 to that of Fig. 4, the e.m.f. becomes less and less until it reaches zero.

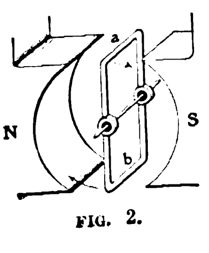


FIG. 2.

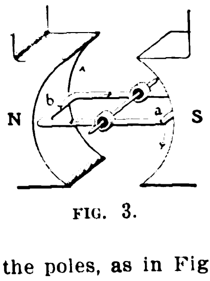


FIG. 3.

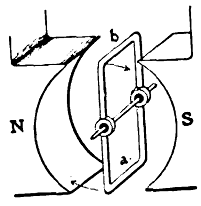


FIG. 4.

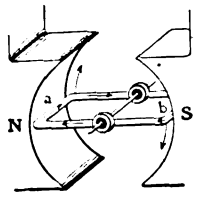


FIG. 5.

When the loop turns through the succeeding 180° another rise and fall of e.m.f. is caused by the wires cutting across the field, but its direction is opposite, with respect to the loop, from that of the first e.m.f., because the direction in which the wires *a* and *b* cut the flux has been reversed. Thus, in Fig. 3, the wire *a* is moving downward through the field, and the direction of the e.m.f. is from back to front of the loop, as indicated by the arrow; the wire *b* is moving upward, and the direction of the generated e.m.f. is, consequently, from front to back. In Fig. 5, the two wires have changed places, and the direction of their e.m.fs. is changed accordingly, the current flowing from front to back in *a* and from back to front in *b*. It should be borne in mind that the e.m.f. will be induced as described, whether the loop is a closed circuit or not; but no current can flow unless there is a closed circuit.

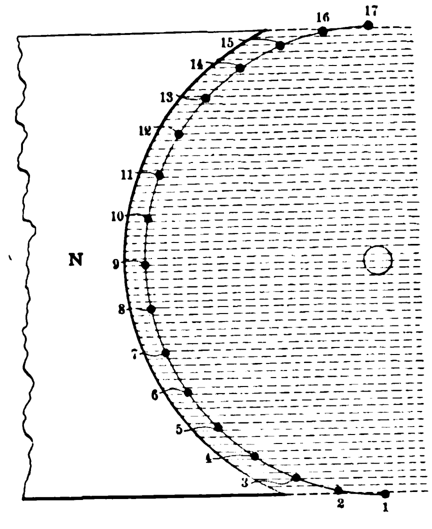


FIG. 6.—VARIATION OF E.M.F. GENERATED.

The variation of the e.m.f. generated is more clearly explained by Fig. 6, in which the dots indicate seventeen equidistant positions of a wire, such as *a* or *b* in the preceding figures, during one-half of a revolution. As a means of elementary illustration, the dotted lines may be taken to represent each one line of force, the magnetic field being assumed to be uniform. When the wire passes from the position *1* to the position *2* it cuts one line of force; passing from *2* to *3*, it cuts two lines; from *3* to *4*, three lines; from *4* to *5*, four lines; from *5* to *6*, five lines; from *6* to *7*, five lines; from *7* to *8*, five lines; from *8* to *9*, six lines. Between *8* and *10* occurs the maximum rate of cutting; then the rate decreases in the reverse ratio of its increase, until in passing from *16* to *17*, only one line is cut. As each adjacent two of these positions are precisely the same distance apart as every other adjacent two, the wire, being moved at uniform speed, will pass from *1* to *2* in the same length of time that is required to pass from *8* to *9*; and, as the number of lines cut per unit of time between *1* and *2* is less than the number cut per unit of time between 8 and 9, the e.m.f. will be correspondingly less.

As it is impossible to draw lines close enough together to even approximate the density of lines of force in a magnetic field (which ranges from 10,000 per sq. in. to several times that number), the illustration of Fig. 6 is not strictly accurate numerically. If there were 200,000 lines in the whole field, the actual number of lines cut between each two neighboring positions of the wire would be as below:

Between Positions.	Lines of Force.	Between Positions.	Lines of Force.
1 and 2	1,921	9 and 10	19,509
2 " 3	5,691	10 " 11	18,759
3 " 4	9,241	11 " 12	17,289
4 " 5	12,436	12 " 13	15,154
5 " 6	15,154	13 " 14	12,436
6 " 7	17,289	14 " 15	9,241
7 " 8	18,759	15 " 16	5,691
8 " 9	19,509	16 " 17	1,921

And, as the e.m.f. varies precisely with the number of lines cut *per second*, it will rise and fall as the wire passes through the half-circle, in exact proportion to the number of lines of force cut per increment of pressure. Thus, if the speed of the wire be 62½ revolutions per second, it will pass from position *1* to position *2*, which is one thirty-second of a revolution, in 1-2000 of a second, and the rate of cutting will be 2000 times the number of lines between the two positions. Representing these by *n*, the e.m.f. generated in passing from any one position to the next will be $2000 \times n \div 100{,}000{,}000$, because a wire must cut 100,000,000 lines per second to generate one volt. The suc-

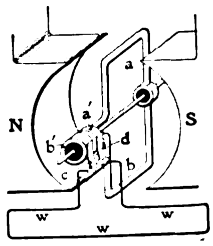


FIG. 7.

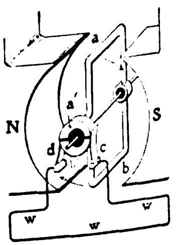


FIG. 8.

cession of e.m.fs. generated during the half revolution in the above case, therefore, would be as follows:

Between Positions	E.M.F.	Between Positions	E.M.F.
1 and 2	.03842 volt	9 and 10	.39018 volt
2 " 3	.11382 "	10 " 11	.37518 "
3 " 4	.18482 "	11 " 12	.34578 "
4 " 5	.24872 "	12 " 13	.30308 "
5 " 6	.30308 "	13 " 14	.24872 "
6 " 7	.34578 "	14 " 15	.18482 "
7 " 8	.37518 "	15 " 16	.11382 "
8 " 9	.39018 "	16 " 17	.03842 "

Referring again to Figs. 2 to 5, it will be evident that while an e.m.f. is rising and falling in one wire, say *a*, an equal and opposite e.m.f. is rising and falling in the wire *b* in precisely the same manner, so that the two e.m.fs. are added in the loop, making a total of twice the values given in the table above.

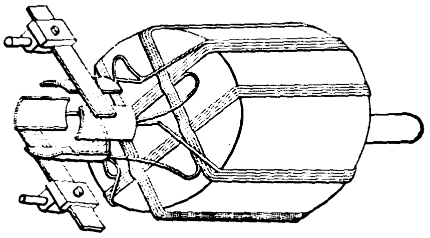


FIG. 10.—ARMATURE, COMMUTATOR AND BRUSHES.

It is evident that the closed loop arrangement shown in these sketches can serve no useful purpose, as the e.m.f. generated would merely force current around through the loop; in order that the current may be utilized, connection must be made between the loop and an outside circuit. This may be accomplished by means of two metal collars, or rings, each attached to one end of the loop and having a stationary conducting strip bearing upon it, as in Fig. 7; or by means of two semi-circular rotating strips and two stationary strips arranged as in Fig. 8. The rings in the former arrangement are designated "collector rings," and the arrangement of segments is a "commutator"; the stationary strips are invariably known as "brushes." In both cases the outside circuit is indicated by the line *w*, representing a wire or other conductor, and the letters *a' b'* indicate the circular strips to which the sides *a* and *b* of the loop are attached.

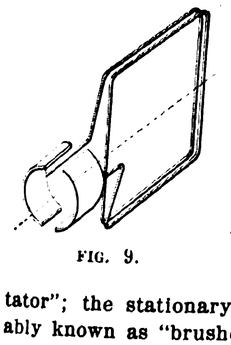


FIG. 9.

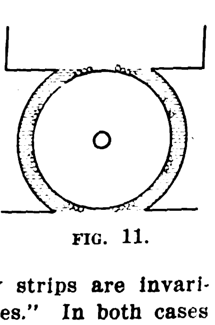


FIG. 11.

Upon analysis, it will be evident that, with the collector rings, the current in the outer circuit, *w*, will rise and fall and reverse precisely as it does in the loop *a b*, whereas, with the commutator, the current in the external circuit will rise and fall in strength, but will always flow through the wire *w* in the same direction.

It was to obtain just this result that the commutator was devised. It performs the function of preventing the reversal of the current in the external circuit by changing each terminal of that circuit from one end of the loop to the other end at just the moment when the current in the loop has reached zero and is about to reverse; this condition being attained when the wires *a* and *b* are moving parallel with the magnetic lines of force, as in Fig. 8. At this moment the brushes *c* and *d* short-circuit the loop by touching both of the commutator segments, *a'* and *b'*.

Now, if the loop be made with two complete turns instead of one, as in Fig. 9, the e.m.f. will be doubled, because the same e.m.f. will be generated in each active stretch of wire, and there are twice as many active stretches of wire as before, in series with each other. And, if a second loop be added at right angles with the first one, this one will be cutting lines of force at the maximum rate while the first loop is cutting none, so that the two will complement each other to a considerable extent, and the current in the external circuit, instead of rising and falling between zero and maximum, will never fall below 0.636 of the maximum value. Fig. 10 shows two such loops mounted on a drum-like core and divided into two sections each, making virtually four individual coils. The commutator has, accordingly, four segments. The function of the core drum, which is made of iron, is to give a better path for the lines of force between the poles; Fig. 11 is a sectional view of this arrangement, from which it will be evident that the distance that the magnetic lines have to travel through air is enormously reduced in comparison with Figs. 2 to 8, inclusive. The core revolves with the coils, and the whole structure is called an armature.

Upon first thought, it will seem strange to give the same name to this complicated structure that is given to a simple bar of iron adapted to bridge the poles of an ordinary electromagnet. The two have one function in common, however, which is to furnish a path of relatively low reluctance for the magnetic lines passing from pole to pole of the magnet; therefore, it is appropriate to a certain extent that they should have the same name. The combination of a magnet with an armature, commutator and brushes such as are shown by Fig. 10, constitutes a dynamo.

◆

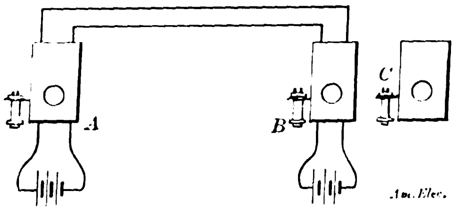
Draining Steam Pipes.—Where valves are placed in steam risers from boilers, it is recommended that a drip pipe be tapped in the pipe above the valve and the pipe drained of condensed steam above it before the valve is opened. When drain taps are fitted in such a position they should always be left open, or, better still, coupled to a steam trap; and so prevent any waste of steam which might otherwise occur. A large number of explosions due to water-hammer action are generally traceable to an inefficient system of draining the pipes.

Letters on Practical Subjects

A Problem in Telephone Connections.

To the Editor, American Electrician:—

The writer was recently confronted with the following problem in telephone connections, and would like to submit it for the consideration of the readers of this paper. There was already installed a two-instrument metallic circuit line with a battery at each end, these two stations being indicated by *A* and *B* in the accompanying sketch. It was desired to add an auxiliary station at *C*, with the connections arranged so that anyone at *A* could call up either station *B* or station *C*, and that either station *B* or station *C* could call up station *A*, but not each other. It was not convenient to run another wire from station *A*, but a gas pipe was available for a return-circuit connection. The problem was to effect the simplest arrangement that would produce the results mentioned.



PROBLEM IN TELEPHONE CONNECTIONS.

A. T. CHASE.
Haverhill, Mass.

◆

As to Elevator Systems.

To the Editor, American Electrician:—

I should be glad to have the opinions of your readers as to the relative merits of electric and hydraulic elevators in actual operation. What has been the experience of AMERICAN ELECTRICIAN readers as to first cost, maintenance, ease of operation, liability to get out of order, safety of passengers, depreciation; in short, which is the best system, all things considered, for large office buildings, such as those in New York City, the building having its own isolated plant?

Brooklyn, N. Y. J. G. OULD.

◆

An Odd Engine Trouble.

To the Editor, American Electrician:—

I am operating a center-crank high-speed automatic engine, 14 x 14 ins., which runs at 238 r.p.m. The cross-head box is adjustable by a wedge and the crank-pin box by a key. One of the crank-pin brasses has a soft plug in it which melts out and stops the engine in case of a hot box. The engine will run nicely night after night without having any attention for several days, and then suddenly heat up and stop. When the brasses are taken out it is found that they only have a bearing at the top and bottom about 1 in. wide across the brass, and do not touch the crank-pin anywhere else. When scraped and fitted to a good bearing surface, and put back, they will be found in a few months to have worn the same way. The engine is a self-oiling engine and gets plenty of oil. I will be much obliged to any readers of the American Electrician who will suggest the cause of the box getting hot and wearing in the peculiar way mentioned.

Minonk, Ill. Arthur E. Jones.

Boiler Testing.

To the Editor, American Electrician:—

I have read with much interest the excellent article on "Boiler Testing," by Chas. L. Hubbard, in the April number of the American Electrician, and in analysing certain of the formulas employed in deducing results from given data and observed performance during the trial, I find some errors and discrepancies, to which I should like to draw the attention of those of your readers who might otherwise be misled thereby.

In the third column of page 171, under computed results, it is stated that the proportion of refuse in the case under consideration is 0.86; this should be .086.

The coal burned per hour should be $5713 \div 8.5$ instead of $5223 \div 8.5$. The horse-power developed during the test should be $(60{,}181 \times 1.046) \div (8.5 \times 34.5) = 214 +$ h.p., instead of $60{,}181 \div (8.5 \times 34.5) = 205$, as the factor of evaporation should have been applied.

The factor of evaporation should have been employed in deducing the boiler efficiency, as follows:

Total heat supplied to boiler, 5713 lbs. of coal × 13,000 B.T.U. per lb. = 74,269,000 B.T.U. Total heat absorbed by boiler = 60,181 lbs. of water evaporated under actual conditions × 1.046 (factor of evaporation) × 966 (heat of vaporization at 212°) = 60,809,049, which corresponds to an efficiency of $60{,}809{,}049 \div 74{,}269{,}000 =$ 81.88 per cent, instead of 72 per cent, as stated.

These errors appear to have been due to hurried preparation, and not to any lack of comprehension on Mr. Hubbard's part, as he is evidently thoroughly conversant with his subject.

I congratulate you on the continued excellence of your journal.

Chicago. Ernest F. Smith.

A Rheostat Trouble.

To the Editor, American Electrician:—

I should like to submit to the readers of the American Electrician the following trouble, with a view to obtaining suggestions concerning its cause and remedy. In starting up a new plant containing alternators, an exciter rheostat has given considerable trouble. Running the alternator up to speed with all of the exciter rheostat cut out, the voltage at the exciter brushes was 125 and the secondary alternating-current voltage was 34. Cutting in the exciter rheostat gradually caused the exciter voltage to decrease, as might have been expected, but the secondary alternating-current voltage rose until about three-fourths of the rheostat was cut in, when the secondary voltage began to decrease. Disconnecting the field wire leading to the rheostat, and putting on a jumper direct from the field to the brush at the exciter, with the resistance of the rheostat all cut in, the secondary alternating-current voltage was brought up to 110, regulating the engine speed by the throttle. Then slowly cutting out the rheostat resistance, the secondary voltage *decreased* very rapidly. I should be glad to have some one explain why these actions occurred.

J. S. Bristol.

Grayling, Mich.

Electrical Catechism

675. How are the molds made for electrotyping?

The molds are made of fusible alloy, plaster of Paris, gutta-percha or wax. For making molds of gutta-percha the object to be copied is fitted with a metallic rim or is placed face up in the bottom of a metallic dish with a rim; the gutta-percha is then heated in boiling water until pliable, and placed in the dish in sufficient quantity to more than fill the dish; the whole is then placed under a press, such as a common letter press, and kept under pressure until quite cold and hard. For making molds in wax, the article is brushed over with sweet oil or boiled linseed oil, the excess oil being carefully wiped off with cotton; the article is laid on a smooth surface and is surrounded by a rim of card or metal standing about a quarter inch higher than the highest point on the article; beeswax containing about one ounce of dry white lead to a pound of wax is then melted and allowed to cool almost to the point of setting; it is then poured carefully over the object so as to avoid air bubbles; as soon as the wax has set, the rim is removed and the wax-covered article is allowed to cool; when cold, the wax cast is easily removed, unless the wax was poured too hot, or unless the article was not sufficiently oiled. An excellent composition for molds is a mixture of two parts of gutta-percha and one of lard, the mixture being melted and used like the wax. Plaster of Paris molds are made by sprinkling the finest plaster into water until it becomes as thick as cream; a thin layer of this is carefully brushed over the object (which has been previously oiled) and then the rest of the plaster is poured on so as to form a mold of suitable thickness; in about an hour it will be set, and can be removed; the cast must then be slowly and thoroughly dried and the plaster saturated with melted paraffin wax to make it waterproof. Casts may be made of some easily fusible metal, such as Wood's metal, composed of four parts by weight of bismuth, two of lead, one of tin and one of cadmium, an alloy which melts at 141° Fahr; this is melted and poured over the object, which should be coated with a film of oil. Molds of metal, plaster and wax are suitable only for objects which are not undercut, and from which the cast may be removed without bending; gutta-percha will bend and stretch to some extent, and may be used on objects slightly undercut. For objects in high relief, or considerably undercut, a mold may be made of common glue, softened by soaking in cold water, and then melted with about one-fourth of its weight of treacle, with 2 per cent of tannin. None of the molds made as indicated above, except that of metal, is a conductor of electricity, and all such much therefore be given a conducting surface before use.

676. How are the molds for electrotyping made conducting?

The most common method is to fasten a copper wire around the edge of the mold and then carefully cover the face surface with a smooth coating of powdered plumbago by means of a fine, soft brush. The plumbago then makes a conducting path from the copper wire to every part which is to be coated with metal. When the mold is of a fusible metal it is necessary to cover the surface with a thin film of oil, or to allow it to tarnish slightly, so that the electrotype will not adhere too strongly.

677. How is the metal coating electrically deposited on the electrotype?

The mold, prepared as indicated above, is suspended in a solution of copper sulphate, made by dissolving 1½ lbs. of crystallized copper sulphate in 1 gal. of water, to which ½ lb. of sulphuric acid is added. The copper wire on the mold is connected with the positive (copper or carbon) terminal of a battery giving one or two volts. A copper plate is placed in the solution facing the mold and is connected with the negative or zinc terminal of the battery. Current is then allowed to flow for several hours at a rate not exceeding 10 amperes per square foot, when a thin coating of copper will be found deposited on the face of the mold. When the coating is of sufficient thickness, the whole is removed from the bath and the mold separated from the electrically-deposited shell. If the copper plate is a copy of a cut or half-tone used for printing, the shell is filled with a backing of type metal, which is then dressed to the proper thickness, and the whole is mounted on a block. When the same copy is to be used in a number of different places electrotypes are made from the original type or form and these electrotypes are sent to the various places.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address.

If a direct-current enclosed arc lamp takes 5 amperes and 80 volts across the arc, is the consumption on a 110-volt circuit 400 watts or 550 watts? J. W. H.

The total consumption of power is 550 watts.

Two shunt-wound generators are operated in parallel with two compound-wound machines on a three-wire system, and one set invariably robs the other; how can this be corrected? F. E. W.

By cutting out the series coils of the compound-wound machine.

Why are the rails of an electric street railway system connected together by copper wires or cables? W. F.

Because the track is one conductor of the supply circuit; the joints of the rails must be bridged over so as to make the track electrically continuous.

What is the difference between an ammeter and a current indicator? (2) What is a zero instrument? C. R.

None. (2) An instrument the needle of which points to zero when the desired result as to current strength or voltage has been obtained.

How can a two-phase or three-phase induction motor be made to run in the opposite direction to that in which it has been running? J. C. M.

A two-phase machine can be reversed by reversing the connections of one phase. A three-phase machine can be reversed by exchanging any two of the three wires.

If two collector rings are put on a 500-volt direct-current motor to take off alternating current, as described in the December, 1898, number of the AMERICAN ELECTRICIAN, what will be the voltage of the alternating current? (2) Could it be used for armature testing? C. W.

About 350 volts, if the actual voltage at the motor brushes is 500. (2) Yes.

Why will a given size of wire in an armature winding stand more current than the same size in a field coil? J. S.

Because the loss of power (due to heating) per unit of effective radiating surface is much lower in an armature coil of a few turns than in a field magnet coil, where there is always a large number of turns and a comparatively small radiating surface.

What is a logarithm? H. S.

The exponent of the power to which it is necessary to raise a fixed number in order to produce a given number. The fixed number is the "base" of the logarithmic system. The base of common logarithms is 10. Thus the common logarithm of 1175 is 3.07; and this is the exponent of the power to which 10 must be raised to produce 1175. Or $10^{3.07} = 1175$, and log. $1175 = 3.07$.

What is the formula for calculating the drop in a three-phase circuit supplying a non-inductive load? C. B. H.

$$E \times \sqrt{\left(1 + \frac{IR}{E}\right)^2 + \left(\frac{IX}{E}\right)} - E = V.$$

in which *E* is the e.m.f. at the load, *I* is the current per wire, *R* is the resistance of a two-wire circuit of the same length, *X* is the reactance of a two-wire circuit of the same length, and *V* is the drop in volts.

How can a 9.6-ampere Brush arc dynamo be changed to a 6.6-ampere machine? (2) How many lamps would the machine maintain after being changed? (3) Is it safer to ground guy and span wires of an arc-lighting system than to put insulators or break knobs in the wires near the poles? W. E. T.

Replace the present armature and field coils with new coils having 1.4 times the present number of turns and wound with wire two gauge numbers smaller than the present wire. (2) About 140 lamps. (3) It is best to do both.

Is it good practice in building armatures to use cast-iron or wrought-iron end plates to secure the laminations so that they can be turned off and the slots milled while the core is on the shaft? G. E. M.

It is preferable to use non-magnetic end plates if these are the full diameter of the armature core. It is not good practice to turn off the armature core, nor to mill the slots; the discs should be absolutely true in the first place, and the slots should be punched before assembling the discs.

Why does a 110-volt dynamo lose its voltage while running and refuse to excite when started up again? H. M.

The drop in voltage while the machine is running is probably due to the shunt winding having too low a resistance, which causes the drop in the external characteristic to occur before full load is reached. The refusal to excite may be caused either by exceptionally soft iron or steel in the frame of the machine—or it may be that the machine is excited normally contrary to the natural tendency of the residual magnetism in the frame.

Why does a 16-c.p. 110-volt lamp burn out when connected in series with a 110-volt 15-ampere heater on a 220-volt circuit? C. B.

Because the lamp is subjected to an abnormal current. The resistance of the lamp is practically 220 ohms. The resistance of the heater is 7.3 ohms, so that the resistance of the two in series is 227.3 ohms. The current that will flow, therefore, is

$$\frac{220}{227.3} = 0.967 \text{ ampere},$$

and the lamp is only intended to stand one-half an ampere.

Can an ammeter, such as is used for secondary alternating-current circuits, be used safely to measure the current in high-tension primary circuits? (2) In connecting an ammeter and a voltmeter in circuit should the voltmeter be connected between the ammeter and the source of current, or on the side toward the load? (3) What is the efficiency of an average direct-current motor of 15 horse-power? A. C. R.

Yes. (2) It makes practically no difference on which side of the ammeter the voltmeter is connected, as the current taken by the latter is so small as to be negligible. (3) About 90 per cent for standard machines; special machines, such as those for elevator and crane service, are usually of lower efficiency.

What is the formula for figuring the total efficiency of a pumping plant from the cylinder of the engine to the water delivered? (2) What would be the formula for a plant in which the engine drives a dynamo and the pumps are operated by motors? W. H. C.

$$\frac{100 \times W \times H}{33{,}000 \times \text{i.h.p.}} = \text{per cent efficiency.}$$

In this formula *W* is the number of pounds of water pumped per minute, *H* is the head in feet, reckoned between the level of the delivery outlet and the level of the supply, and *i.h.p.* is the indicated horse-power of the engine. (2) The formula is precisely the same for both cases, as you are figuring from the engine cylinder to the delivery water. The over-all efficiency, of course, might be considerably different, but the formula for ascertaining it would be the same.

What is the formula for figuring horse-power in making Prony brake measurements? (2) Why is it necessary to pour soap and water on the brake-shoes during the test? C. H. M.

$$\frac{2\pi L\ W\ \text{r.p.m.}}{33{,}000} = \text{horse-power.}$$

In this formula *L* is the length of the lever in feet from the center of the shaft to the point from which the weight is suspended, and *W* is the weight in pounds. It is common practice to make the length of the arm 63.024 ins., in which case the formula reduces to:

$$\frac{W \times \text{r.p.m.}}{1000} = \text{horse-power.}$$

(2) In order to lubricate the brake-shoes and prevent their being burned by the friction. The water also reduces the heating by absorbing and carrying away heat units.

Why does weakening the field of a shunt-wound motor cause its speed to increase? (2) If the speed continues to increase as the field is weakened, why does not the motor run at maximum speed with the field unexcited? W. G. M.

The motor armature must generate a counter e.m.f. equal to the line e.m.f. minus the drop in the armature winding, and the counter e.m.f. is proportional to the strength of the field and to the speed. Therefore, if the field be weakened, the armature must run faster in order to generate the required e.m.f. (2) The speed will not increase indefinitely as the field is weakened. A point will ultimately be reached, if the fuses have not blown in the meantime, where the "drag" between the magnetic field and the armature wires will not be sufficient to pull the load, and the motor will slow down, and the curent will become greater and greater, until the fuses go or the machine is damaged.

STURGESS WATER-WHEEL GOVERNOR.

In order to make a water wheel run at constant speed when operated under a variable load, it is obviously necessary to vary the amount of water delivered to the wheel at each change of the load, and it is equally obvious that with the ordinary reaction type of turbine the only practical method of doing this is to vary the gate opening. Unfortunately, the variation of the gate opening does not under all conditions produce the variation in power desired, and may at times have even the opposite effect from the one desired. For example, with a wheel running under full gate there will be a certain velocity of water in the penstock, and if the gate be suddenly closed to one-fourth its full opening, the velocity of the mass of water in the penstock will be checked and a large amount of its kinetic energy will be transferred to the stream of water passing through the wheel, which stream may thus have its velocity increased sufficiently to accelerate the speed of the wheel to an abnormal point. Conversely, if after the wheel has been running steadily at one-fourth gate the full load be thrown on and the gate instantly opened to its full area, there will be a perceptible time interval between the opening of the gate and the acceleration of the water in the penstock to the point necessary to maintain normal speed at the water wheel; consequently, there will be a momentary fall in speed.

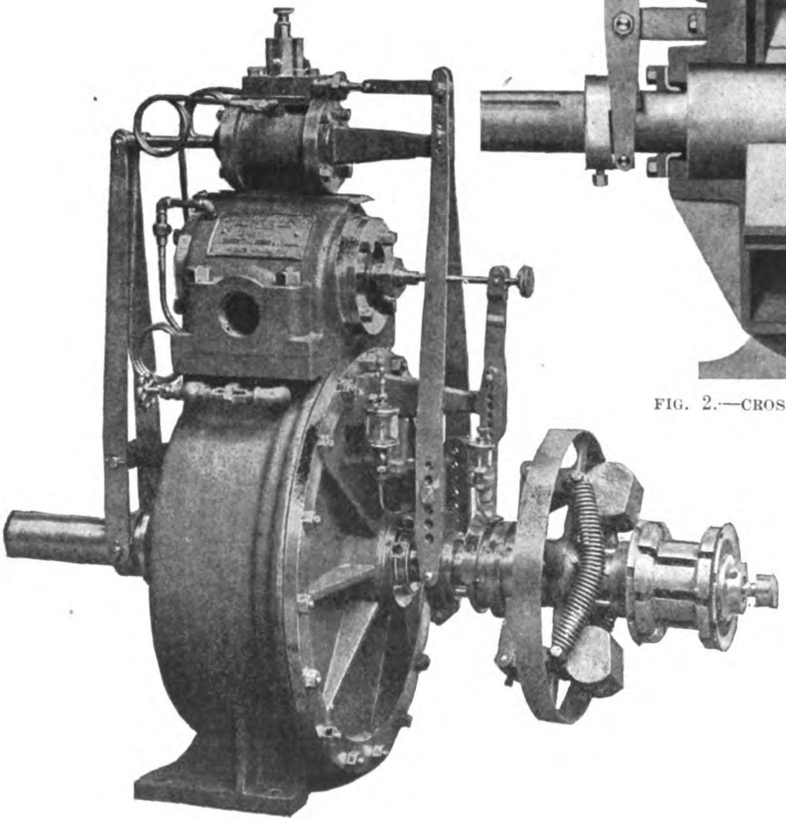


FIG. 1.—STURGESS WATER-WHEEL GOVERNOR.

So, even if a good governor could be made to fulfill the ideal requirement of opening and closing the gate synchronously with increase or decrease of load, there would still be a momentary variation in speed by the wheel. It is evident that in order to reduce the duration of the momentary increase or decrease of speed due to change of load, a governor must open and close the wheel gate as promptly and as rapidly as possible, and yet not overrun appreciably, as overrunning entails instability. With a view to accomplishing this result, the Sturgess Governor Engineering Company, Troy, N. Y., has brought out the form of governor illustrated herewith.

This machine is of the hydraulic type, that is to say, the water wheel gate is actuated by hydraulic pressure. Instead of using a cylinder and piston of the ordinary type, however, an arrangement based on the general principle of the rotary engine is employed, in which however, the rotary part makes only 0.87 of a revolution. On the gate shaft is mounted a rotary piston which is enclosed in a cylindrical chamber; this chamber constitutes the lower part of the machine. Immediately above this chamber are the valve chest and valves controlling the motion of the rotary piston. The main valve is of heavy, substantial construction, and is operated hydraulically, its motion being controlled by a pilot valve mounted in the center of it and adapted to open ports in the main valve, as indicated in the sectional view, Fig. 2. The pilot valve is actuated by a centrifugal governor of the ordinary shaft type, which revolves loosely on an extension of the rotary piston shaft and is belt-driven through the medium of the expansible pulley shown on the extreme right, the power for driving being derived from the main turbine shaft.

On top of the valve chest is mounted a dash-pot, which is adapted to slide on its seat in a direction parallel with the motion of the main valve. The tendency of this dash-pot is to remain in the center of its travel, as indicated in Fig. 2, irrespective of the position of the piston within. Upon variation of the load the centrifugal governor operates the pilot valve in the proper direction to effect the further opening or partial closing of the turbine gate, according to the necessity of the case. As soon as the gate shaft begins to move, the cam near the left-hand end of that shaft operates the vertical lever, which in turn forces the piston of the dash-pot in one direction or the other, according to the direction in which the gate shaft has moved. As the dash-pot is filled with water (or oil), the movement of its piston causes the dash-pot itself to slide to the right or left, moving the long lever on the right-hand side one way or the other; the lower end of this lever is connected through a sliding collar to the expansible pulley, which is expanded by movement of the lever in one direction and contracted by movement in the opposite direction. Connection is made between the main valve chamber and the valve chest of the dash-pot by means of a small pipe having two complete turns in it so as to make it flexible and allow it to follow the movements of the dash-

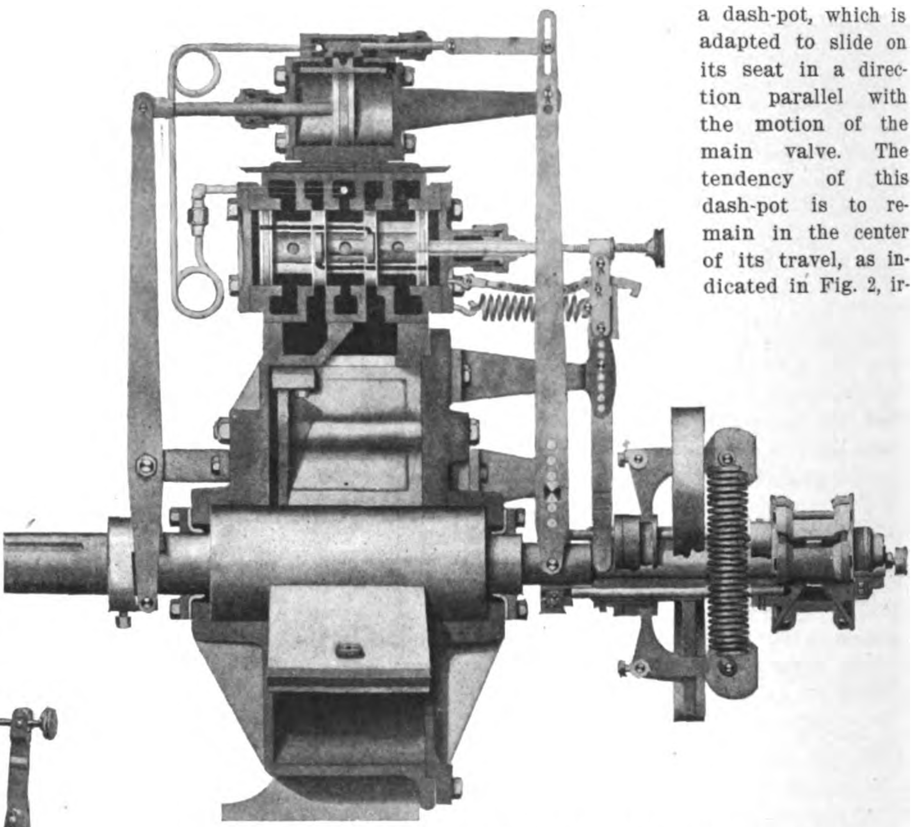


FIG. 2.—CROSS-SECTION OF STURGESS WATER-WHEEL GOVERNOR.

pot to the right or the left. The operation of the governor is as follows:

If there has been an increase in load, for example, the speed of the turbine will be checked, and the centrifugal governor will move the pilot valve in such a direction as to cause the turbine gate to be opened wider by the rotary piston. As soon as the gate shaft begins to move, the cam on the left throws the dash-pot piston and dash-pot to the right, and this causes the contraction of the expansible pulley, which slightly increases the speed of the centrifugal governor, compensating for the drop in speed by the turbine shaft and counteracting the tendency of the governor to carry the pilot valve to the extreme limit of its travel. The motion of the dash-pot to the right causes its slide valve to uncover the ports, admitting pressure to the left of the piston and relieving the pressure on the right of the piston. This checks any further advance of the dash-pot itself, and as soon as the gate shaft comes to a stop the dash-pot is gradually returned to its mid position by the pressure on the left-hand side of its piston. In returning to the central position, the dash-pot increases the diameter of the expansible pulley; this would of itself reduce the speed of the centrifugal governor and further affect the valve, but, as the result of the previous movement of the gate shaft, the turbine speed will have picked up and the increase in its speed will counteract the increase in the size of the expansible pulley and maintain the speed of the centrifugal governor normal.

This arrangement is said to give an extremely sensitive gate control and at the same time to prevent overrunning and "hunting." The rotary piston has a range of 0.87 of a revolution, so that its shaft can in most cases be coupled directly to the gate shaft of the turbine. Of course, when the gate shaft must take more than 0.87 of a revolution, the connection between the governor shaft and gate shaft is made by means of gears of the proper ratio.

The hydraulic pressure for the operation of the valves and the rotary piston is obtained from the penstock, or some similar head of water, whenever this is practicable; when it is not, a pump and receiver are supplied, and oil is used as the working fluid for the governor.

The governor is also made with a straight piston and cylinder for operating the gate rigging whenever the latter is of such form as to require a rectilinear motion instead of a rotary one. The valves, dash-pot and other features are exactly the same, however, as in the rotary type.

A NEW TELEGRAPH REPEATER.

The number of telegraph repeaters invented and reinvented annually is comparable to the number of railway car couplers and electric light switches, and one listens with skepticism to each announcement of a new repeater. The instrument here described, however, is not a fit subject for incredulity, but is actually different from any form of telegraph repeater heretofore devised. Fig. 1, herewith, illustrates the transmitter, which consists of an ordinary repeating sounder, having an auxiliary armature lever which, like the main lever, carries a spring circuit-closer. The auxiliary armature lever is pivoted immediately above the main lever and to the same standard, and the armature which it carries is much smaller than the main armature and located immediately above it, as the illustration plainly shows. The main lever and auxiliary lever have entirely separate adjustments throughout. The main lever opens and closes the line into which the message is repeated, in the ordinary manner, and the auxiliary lever short-circuits the armature contacts of the relay in that line. This is clearly shown by the diagram, Fig. 2. where the relay *R* is included in the line going east and operates the transmitter *T*, which repeats to the line going west.

The operation is the same as that of the familiar double-transmitter repeater which was in use a number of years ago. The silencing of the transmitter of the receiving line by short-circuiting the relay contacts is, however, the only part of this repeater which corresponds to the old double-spring transmitter arrangement. In the present repeater the auxiliary armature which silences the transmitter of the receiving line does not follow the main armature down immediately, but there is a considerable time lag, which compensates for the sluggish action of the relays when the lines are heavy. The result is that there is no kick or flutter of the transmitter on the receiving side due to heavy circuits. Any tendency in this direction may be immediately eliminated by adjusting the spring of the auxiliary lever so as to increase the margin of time between the downward stroke of the main lever and the downward stroke of the auxiliary lever. The contact spring on the auxiliary lever is so adjusted that the local circuit which it closes is not opened until the lever has almost reached the limit of its downward stroke; consequently, this circuit is closed as soon as the lever begins its upward stroke, in response to the upstroke of the key of the sending operator.

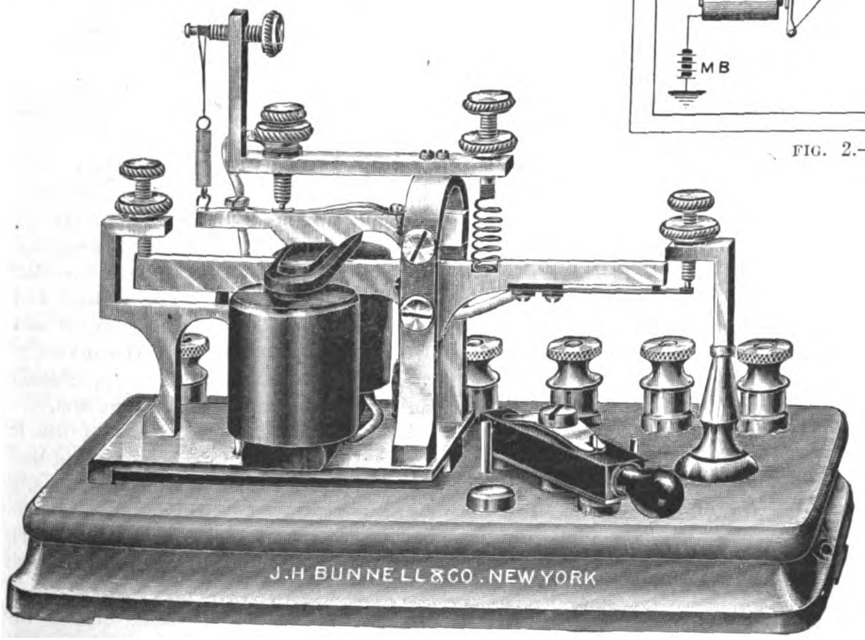

J.H BUNNELL & CO. NEW YORK

FIG. 1.—GHEGAN TELEGRAPH REPEATER TRANSMITTER.

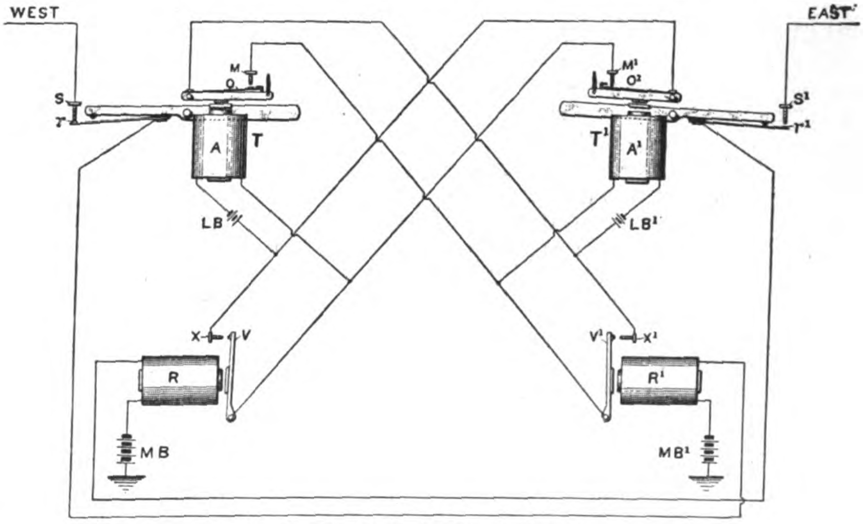


FIG. 2.—DIAGRAM OF CONNECTIONS.

To anyone familiar with the fundamental principles of a telegraph repeater, an explanation of the diagram is not necessary. For the information of those who are not so familiar the following is submitted: The relay *R*, included in the east line, operates the transmitter *T*, which, through its spring and contact, *r* and *s*, closes and opens the west line. The opening and closing of this line, of course, causes the relay *R'* to operate its armature, and as this relay operates the transmitter *T'*, signals from east to west would be subject to interference unless the transmitter were held closed when signals are coming in on the east line. This is accomplished by the contacts of the auxiliary lever on the transmitter *T*, which short-circuit the armature contacts of the relay *R'* as soon as the auxiliary transmitter lever starts upward, thus holding the other transmitter *T'* closed. The diagram shows the apparatus in operation from west to east; that is to say, signals from the west wire are being repeated into the east wire. The operator on the west wire having his key open, the relay *R'* which is in that wire has released its armature, opening the local circuit of the transmitter *T'* and allowing its armature to open the east wire. Before the spring *r'* opens the east wire, however, the contacts of the auxiliary lever close the local circuit of the transmitter *T'*, holding its lever in the closed position, so that it cannot interfere with the signals coming in on the west wire. This repeater is the invention of Mr. J. J. Ghegan, and is manufactured by J. H. Bunnell & Co., New York.

STOKING IN THE METROPOLITAN RAILWAY POWER HOUSE.

The Ninety-sixth Street station of the Metropolitan Street Railway Company of New York enjoys the distinction of being the largest electrical power plant in the world in actual operation at the present time. The magnitude of the enterprise, however, is not its most interesting nor its most important feature. The entire system presents a most interesting study for engineers and managers of large power plants and street railway properties, as it embodies the latest improvements, developments and refinements in modern street railway practice. In no department is this fact more apparent than in the steam-generating plant of 80 Babcock & Wilcox boilers, of 300 horse-power each, with the auxiliary apparatus involved. The boilers were built to carry 200 pounds, but, at the pressure adopted for the station, 160 pounds, they will have a rated capacity of 250 horse-power, although they are capable of 300 horsepower. These boilers are supported by steel beams connected with the steel structure of the building, and they are thus entirely independent of the brickwork and of the floor itself, this part of the equipment having been installed before the brickwork was put in place.

The boilers were equipped with Roney mechanical stokers by Westinghouse, Church, Kerr & Co., and this plant has the distinction of being the largest installation of mechanical stokers in the world in actual operation. There are other plants now in course of construction in New York, which, when completed, will have larger capacity (and these, too, are being equipped with Roney mechanical stokers), but for some time the Ninety-sixth Street station of the Metropolitan Company, with its 23,500 horsepower boiler capacity, can rightly claim the distinction of the leader as to the number and capacity of stokers, as well as in the magnitude of its other equipment.

The Roney stoker is, in a general way, familiar to all engineers, but a brief description of the latest form of the stoker will doubtless be interesting. The details of construction are shown in the diagrammatic engraving, Fig. 1. The equipment consists of a hopper for receiving the coal, a set of rocking grate-bars, stepped to form an incline at an angle of 37° with the horizontal, and a dumping grate at the bottom of the incline for receiving and discharging the ash and clinker. The dumping grate is divided into several parts for convenience in handling.

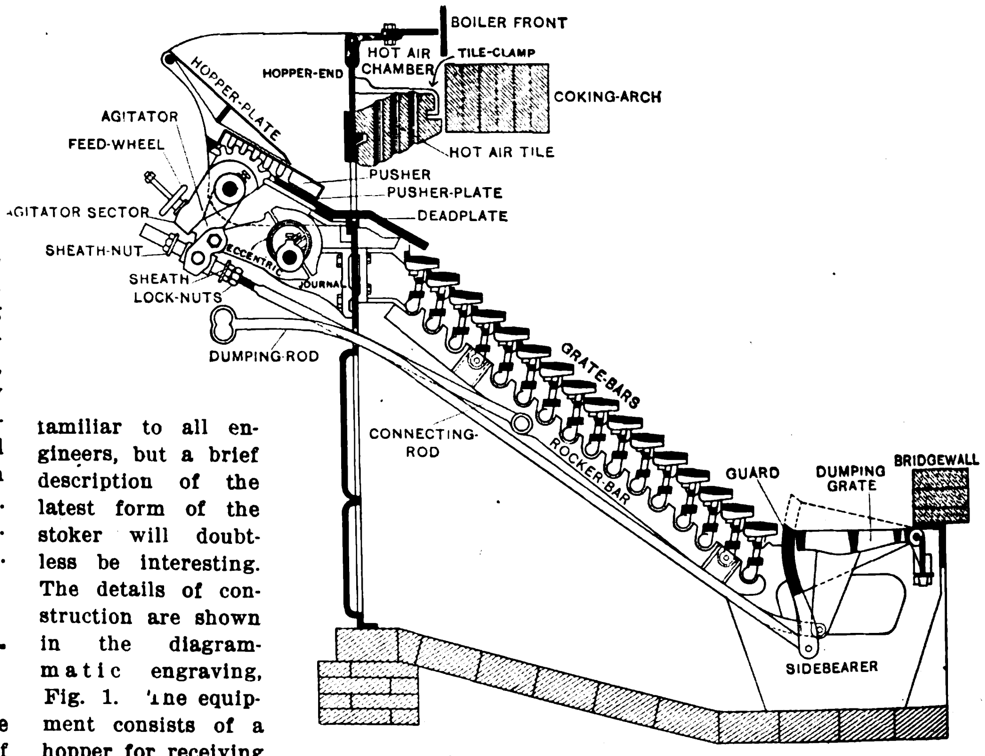


FIG. 1.—ARRANGEMENT OF RONEY STOKER.

Coal is fed to the inclined grate from the hopper by a reciprocating pusher, which is actuated by the agitator and agitator-sector. The grate-bars rock through an arc of 15°, assuming alternately the inclined position and the stepped position indicated in Fig. 2. The grate-bars receive their motion from the rocker-bar and connecting-rod, and these, with the pusher, are also actuated by the agitator, which receives its motion through the eccentric from a shaft attached to the stoker front, under the hopper. The range of motion of the pusher is adjustable by means of the feed-wheel from no stroke to full stroke, and the amount of coal pushed into the furnace may, therefore, be regulated according to the demand for steam. The motion of the grate-bars is similarly regulated and controlled by the position of the sheath-nut and lock-nuts on the connecting-rod.

Each grate-bar is composed of two parts, a vertical web provided with trunnions at each end, which rest in seats in the side-bearers, and a fuel-plate, ribbed on its under side and bolted to the web. These fuel-plates carry the bed of burning coal, and, being the wearing parts, are made detachable, in order to reduce the cost of replacement. The webs are perforated with longitudinal slots to disclose the condition of the fire without opening the doors; free access may be had to all parts of the grate to facilitate the removal of clinker when necessary. The slots in the webs also serve the important purpose of passing air to the furnace, the supply being thereby made ample for the highest practicable rate of combustion.

Anthracite coal is burned under half of the boilers in the Metropolitan plant. The stokers are fitted with a guard, which may be raised to prevent the small anthracite coal from sliding when the dumping grate is dropped to discharge the accumulated ash and clinker. On restoring the dumping grate to its normal position, the guard is dropped. The design and construction of the dumping grate and guard are clearly shown in the diagrammatic illustration, and their operation will be readily understood therefrom.

In operation, the entire bed of fire is visible from the under side of the grate. Clinkers can be seen as they form, and may be dislodged without opening the doors. Then, too, if the fire should burn unevenly, it can be detected instantly and corrected without trouble.

As is well known in steam circles, the Roney stoker will handle either hard or soft coal, separately or mixed, without alteration in the arrangement or construction of the stoker; only a different adjustment of the feed and grate actuating mechanism is required. The supply of coal fed to the furnace is regulated by the feed-wheel, and the motion of the

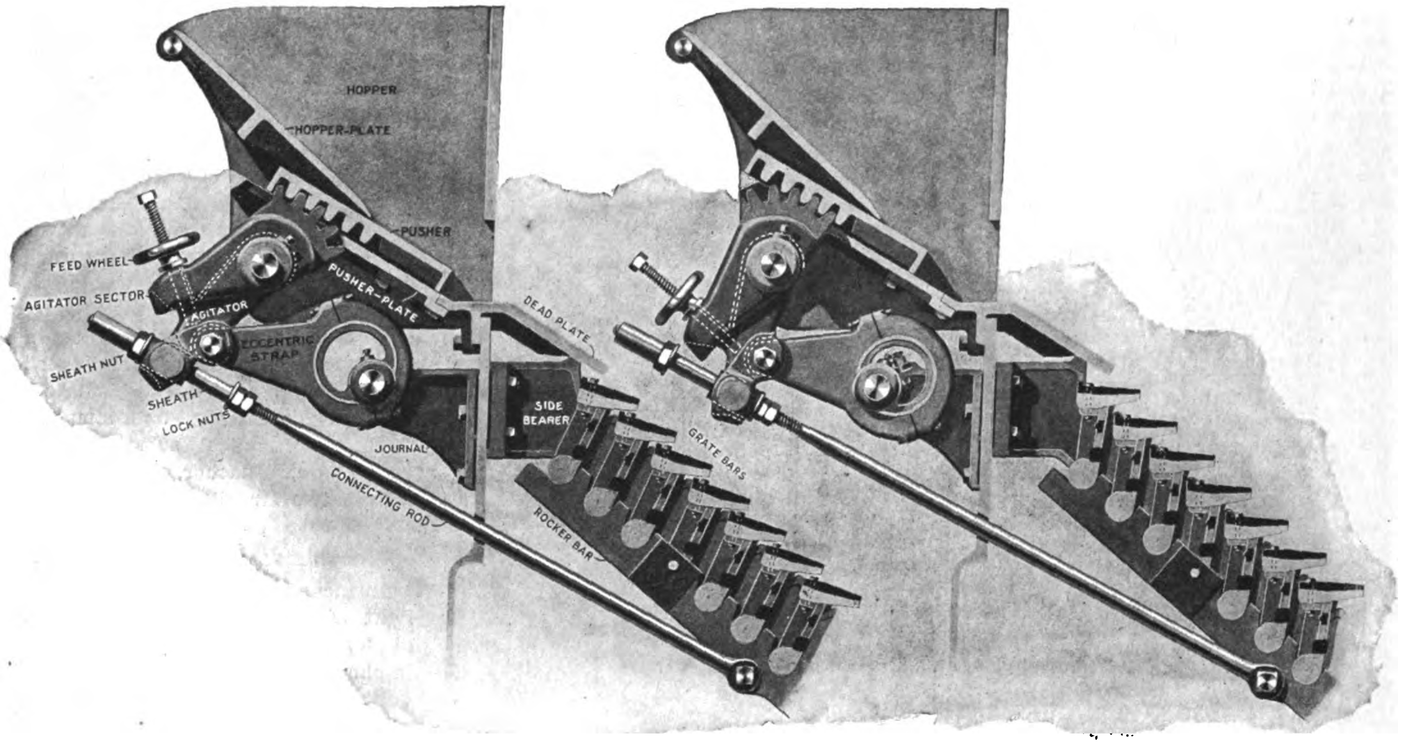


FIG. 2.—SHOWING THE MANNER IN WHICH THE STOKER FEEDS.

grate-bars by the position of the lock-nuts, and these adjustments are easily made by any fireman.

The stokers are operated by small 4-in. x 4½-in. Westinghouse engines, designed especially for this service. The engines are of the enclosed type, with all moving parts entirely protected from dust and dirt; the moving parts run in a bath of oil, and so do the worm and worm gear through which the engine is direct-connected to the stoker mechanism. The worm gear housing is attached direct to the engine frame and housing, making a complete and simple construction. The lubrication is entirely automatic, and this feature cuts down attendance to such a point that it is not a factor in the distribution of the power-house labor. The operation and adjustment require so little skill that they can be successfuly performed by the ordinary fireman. Each floor in the boiler-house is divided into four sections, and one engine is sufficient to run a section, but a reserve is installed as a safeguard against possible accident to driving-gear or shafting.

Although the engines are small, they show a low water-rate, giving under good conditions an economy of 42 pounds of water per horse-power. Taking the average results of several tests of the power required to drive Roney stokers under heavy loads, it is found that to operate stokers for 100 rated boiler horse-power the stoker engines require about 0.1 indicated horse-power, or 4.2 pounds of steam per hour. This amount of water is insignificant, as it represents only between 0.1 and 0.2 of one per cent of the water evaporated by the boilers.

Mr. M. G. Starrett, the chief engineer of the Metropolitan Company, has contributed some interesting information upon methods employed by the management. He states that thus far samples of flue gases have been taken from each boiler room once during each shift. The stoker operators in each room are held responsible for the quality of the flue gas coming from that room. With mechanical stokers all through, it is possible to insist on closer regulations of the quality and temperature of the flue gases than would be possible with hand firing. With mechanical stokers, there is no reason why, with proper attention under ordinary running conditions, the flue gases should not show continuously approximately the same percentage of air, carbon dioxide and carbon monoxide. The proportion of the latter, which is unburned fuel, should be, of course, as low as practicable. The rate of feed, thickness of coal and amount of air admitted to the fire are all practically under the control of the stoker operators, and if the proportion is not such as to give the best results it is the fault of the stoker operators. As yet the engineering department has not attempted to set any standard for the stoker operators to maintain. The samples of flue gas in each case are taken from the back connection of the boiler. All of these show nearly perfect combustion.

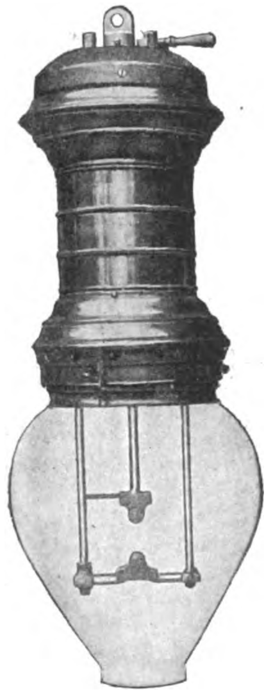
The following figures are taken from the record book of the Metropolitan station, and show the reports from the stoker room for one month, extending from January 10th to and including February 10th. It should be borne in mind that these records do not show the best results; on the contrary, they may be said to show the poorest results, for the inspector makes it a point to select poor fires rather than good ones for analysis.

FLUE GAS ANALYSIS.

	Soft Coal.					Hard Coal.				
Date	CO	CO_2	O	N	Temp.	CO	CO_2	O	N	Temp.
Jan. 10........	.0	14.1	3.9	82.	575	0.0	9.2	10.8	80.	575
11........	.6	15.0	2.2	80.2	500	0.0	11.	8.6	80.6	580
12........	..	....	...	....	...	...	....	....	....	...
13........	0.0	12.4	6.7	80.9	540	0.0	11.2	9.0	79.8	615
14........	0.0	13.6	5.3	81.1	530	0.0	10.0	10.2	79.8	575
15........	0.0	12.0	7.1	80.9	475	0.0	10.3	9.9	79.8	575
16........	0.0	13.2	4.9	81.9	540	0.0	13.2	6.4	80.4	745
17........	0.0	10.5	8.7	80.8	550	0.0	9.8	10.3	79.7	685
18........	1.2	15.0	2.0	81.8	710	0.0	12.6	6.8	80.6	635
19........	...	....	...	....	...	...	....	....	....	...
20........	0.0	10.5	8.3	81.2	525	0.0	10.4	9.8	79.8	...
21........	0.0	13.0	5.6	81.4	510	0.0	12.8	7.2	80.	545
22........	0.0	13.0	5.6	81.4	510	0.0	12.8	7.2	80.	545
23........	.3	14.9	3.1	81.7	525	0.0	13.0	6.8	80.2	685
24........	0.0	12.8	5.8	81.4	475	0.0	9.0	10.2	80.8	570
25........	...	....	...	....	...	...	....	....	....	...
26........	...	....	...	....	...	...	....	....	....	...
27........	.5	13.3	3.9	82.3	545	0.0	10.8	9.4	79.8	550
28........	0.0	12.8	5.6	81.6	570	0.0	11.8	8.0	80.2	580
29........	0.0	13.0	3.2	80.0	745	0.0	10.8	8.9	80.3	540
30........	.8	15.4	1.6	82.2	700	0.0	10.4	9.2	80.4	505
31........	0.0	12.0	6.4	81.4	560	0.0	9.4	11.0	79.6	520
Feb. 1........	0.0	12.0	6.2	81.8	575	0.0	10.4	9.6	80.0	500
2........	...	....	...	....	...	...	....	....	....	...
3........	.1	13.2	5.6	81.1	500	0.0	8.6	11.5	79.3	540
4........	.4	15.6	2.0	82.0	630	0.0	12.2	7.5	80.3	570
5........	0.0	12.4	6.0	81.6	515	0.0	9.4	10.6	80.0	550
6........	0.0	13.6	4.6	81.8	650	0.0	8.0	12.0	80.0	510
7........	0.0	14.4	4.0	81.6	560	0.0	11.0	8.6	80.4	625
8........	.4	11.0	6.4	82.2	465	0.0	9.0	10.6	80.4	485
9........	...	....	...	....	...	...	....	....	....	...
10........	0.0	12.2	6.6	81.2	525	0.0	13.2	6.0	80.8	575

New Apparatus and Appliances

A NEW SERIES ARC LAMP.



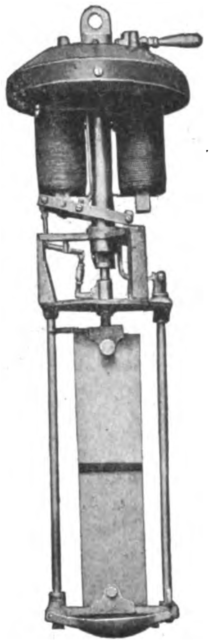


FIG. 1.—PHILADELPHIA ARC LAMP.—FIG. 2.

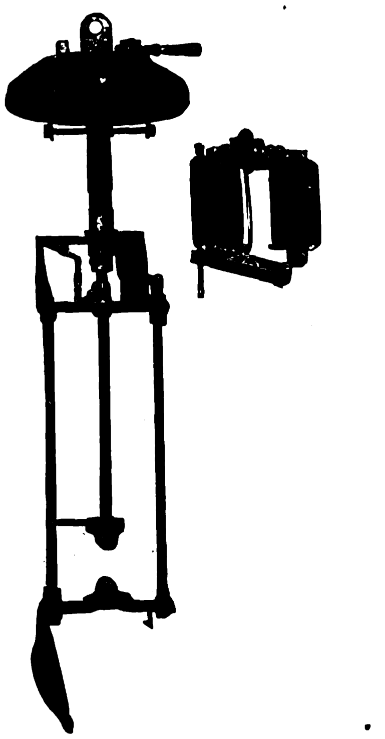


FIG. 3.—PHILADELPHIA ARC LAMP.

The accompanying engravings, Figs. 1, 2 and 3, illustrate a remarkably simple arc lamp, which has been brought out by the Philadelphia Electrical & Manufacturing Company, Philadelphia, Pa. The carbon feed is of the differential magnet type, a simple horseshoe core being employed with the series coil on one limb and the shunt coil on the other, as indicated in Fig. 3. The armature is connected to the carbon rod clutch through two short links and a lever, as clearly shown in Fig. 2, making a simple and strong mechanism. The carbons used are flat plates, as indicated in Fig. 2, of the type which was used some years ago for alternating-current work. In order to prevent the upper carbon from twisting out of alignment with the lower one, the upper carbon-holder is provided with a guiding forked finger, the fork of which engages the left-hand side rod of the lamp, as viewed in the engravings. The lower carbon fits loosely between the jaws of the holder, and is held by two thumbscrews, one on each side, by means of which it is adjusted to meet the upper carbon squarely. Beneath the bottom carbon-holder is a swinging dish for the retention of carbon ash. When the lamp is trimmed, this dish is swung downward to the position shown by Fig. 3, and the dust brushed out. Any of the usual forms of globe may be used with the lamp, but Fig. 1 illustrates it with a special form, open at the bottom and without the dust cup beneath the lower carbon-holder. This form is used for street lighting, in which case the carbon dust is allowed to drop out of the globe. A very simple and reliable cut-out is provided, together with a starting resistance coil, in the top of the case. This cut-out is closed by the action of the magnet armature when the arc becomes abnormal.

Notwithstanding the extreme simplicity of the mechanism, the feeding is extremely gradual, and the length of the arc can be regulated very closely; a voltmeter connected across the carbons with the feed adjusted for 50 volts showed a fluctuation between 48½ and 50 in a test made in the presence of the writer. These lamps are built to run on either 6.6-ampere or 9.6-ampere circuits, and any lamp can be changed from one strength of circuit to the other by merely changing the magnet, which is removable intact, without disturbing any other parts.

SOLENOIDAL FLASHER.

The Reynolds Electric Company, of Chicago, has brought out a new automatic flasher for the purpose of alternately lighting two sign circuits or making and breaking a single circuit. Referring to Fig. 4 it will be noticed that there are two solenoids working on the ends of a rocking arm, each of which has combined with it an oil dash pot, the solenoid itself being submerged in the oil. When the circuit is closed through one of these solenoids, its core is drawn slowly down into the dash pot until the quick-break switch, shown in the foreground, snaps from one contact to the other. The solenoid on the other end of the rocking arm is then cut into circuit and draws its core slowly down until the switch is thrown over to the opposite contact. It is evident that the switch is thrown alternately from one circuit to the other at intervals depending on the speed for which it is set. This may be varied by changing the length of stroke at which the switch will throw over. In the device shown the circuit is closed and opened by combination carbon and copper contacts, the arc formed at the time of breaking the circuit being taken by the carbon, as in all modern circuit-breakers. In another form of flasher, a magnetic blow-out is used. The device is intended as a simple, durable and economical substitute for the motor-operated flasher, where it is desired to flash two circuits only.

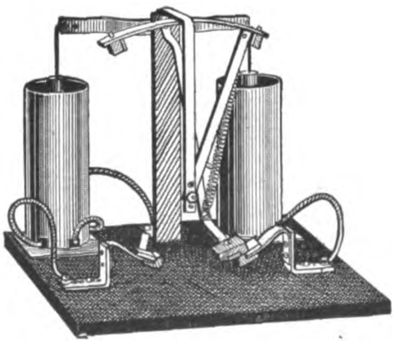


FIG. 4.—SOLENOIDAL FLASHER.

A NEW REGULABLE INCANDESCENT LAMP.

An incandescent lamp capable of giving light of three different intensities, and of yielding a consequent saving in energy, is shown by Fig. 5, herewith. These results are obtained by the use of a multi-filament lamp and a multi-contact socket, which resembles the ordinary socket in appearance, but which has an ingenious construction of socket contacts by which the connections of the lamp filaments are

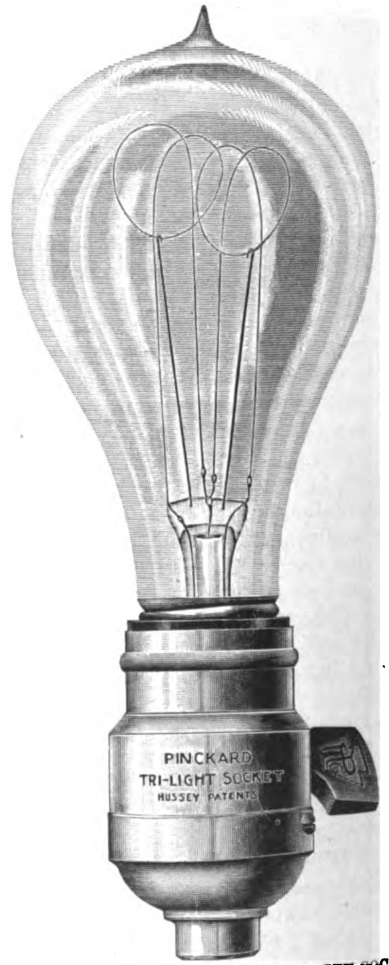


FIG. 5.—TRI-LIGHT REGULATING KEY-SOCKET AND LAMP COMPLETE.

varied, and consequently a different intensity of light is obtained. In the case of the 16-c.p. double-filament lamp shown, turning the key once throws both filaments in series, and gives a light of approximately 2 candle-power; a second turn leaves but a single filament in circuit, giving a light of 8 candle-power; and a third turn throws in both filaments, giving a light of 16 candle-power. A fourth turn of the key throws both filaments out of circuit and extinguishes the light. The Pinchard "Tri-light" lamps are manufactured by the Tri-light Electric Company, of Birmingham, Ala., for maximum candle-powers of 8, 10, 16, 32, 50 and 100. Any standard Edison-base lamp can be used with the Tri-light socket, and Tri-light lamps can be used with any standard Edison socket; but in the former case no gradation of light is obtained, and in the latter case but one filament gives illumination. The key socket is connected up in the ordinary manner, as is also the wall socket. With keyless sockets holding lamps in places of inconvenient access, a special regulating switch is used. Where ordinary sockets are already in use, a combined socket and attachment plug, made with the Edison, Thomson-Houston or Westinghouse base, is furnished, which screws into the existing socket. Charles I. Hills, of New York, is the general sales agent of the company.

TELEPHONE PROTECTORS.

In addition to manufacturing fuse-protecting apparatus for all kinds of electrical circuits, the D. & W. Fuse Company, of Providence, R. I., also manufactures a line of telephone-protecting apparatus. Fig. 6, herewith, shows a variety of this apparatus intended to afford protection for telephones against lightning and crosses with high-tension lines. This protector embodies a lightning arrester for relieving the line of high electrostatic potentials, and also fuses and sneak coils intended to prevent damage by heavy currents. The fuse is constructed on the same lines as the company's high-tension enclosed fuses, and it is said to operate satisfactorily on a 3000-volt short-circuit. The sneak coils are built to operate on currents of from one-tenth to five-tenths ampere; those working on two-tenths ampere being recommended for general telephone service. The lightning-arrester is of the carbon plate type, consisting of a carbon block separated from a ground plate by mica or an insulated waterproof film. With the mica an air-gap of 0.008 in. is provided, while with the film only 0.0025 in. separates the carbon from the ground plate. The makers recommend the latter type of arrester, which is said to practically keep the line grounded with regard to electrostatic effects, while at the same time it tests clear of grounds for the operating and other currents employed. Since trouble from slight leakages are more common than absolute crossings, the sneak coil is made to operate when such currents are diverted through the instruments, and it can be easily renewed. It consists of a very small, close-wound coil made in two parts, which are under tension with reference to each other, these being soldered together by a solder of special composition having a very low melting point. The whole apparatus is enclosed in a capsule of hardened gelatine.

THE ADAMS SECONDARY GENERATOR.

The Western Electrical Supply Company, of St. Louis, Mo., has recently perfected and placed on the market the device shown by Fig. 7 herewith, which is claimed to fulfill all the functions of a primary battery and possesses a capacity for handling heavy work continuously without running down and subjecting the service to occasional interruption. The principle is essentially that of a step-down transformer, but with modifications in construction to render it particularly available for the purpose intended, which is to displace primary batteries where a continuous, twenty-four-hour, alternating electric light service is maintained. The apparatus is made in two sizes, the smaller of which is claimed to be capable of handling the entire electric bell and annunciator system of a modern office or flat building, and is said to consume about one watt in the 7200 alternation type, and about ¾ watt in the 133 cycle machine for continual operation. The larger size has twice the capacity of the smaller size, and is designed for use on heavy electric door openers, annunciators, burglar-alarms, gas-lighting systems, and for small power purposes, such as supplying the necessary current for operating small, direct-current toy motors, etc. It is said to consume from 1¼ to 1½ watts. Annunciators, door openers, and, in general, all devices having a considerable impedance in the windings, usually require, on alternating current, somewhat higher pressures for their operation than is preferable for use with bells, and to meet this requirement the apparatus is built to supply three secondary pressures, the load being taken in any proportions from the various terminals. The apparatus is said to be fireproof, and to meet the underwriters' approval.

AUTOMATIC OIL FILTER.

In the oil filter shown by Fig. 8, herewith, the filtering process is carried on without the use of any filtering material other than water. Pure water is poured into the perforated pan at the top of the filtering chamber, which is filled as full as the overflow will allow, and if necessary this water may be heated by means of a steam pipe situated in the bottom of the filter, in order to facilitate the filtering process. The waste oil is poured or pumped in at the top, *A*, and passes through the strainers in the pans, *B B*,

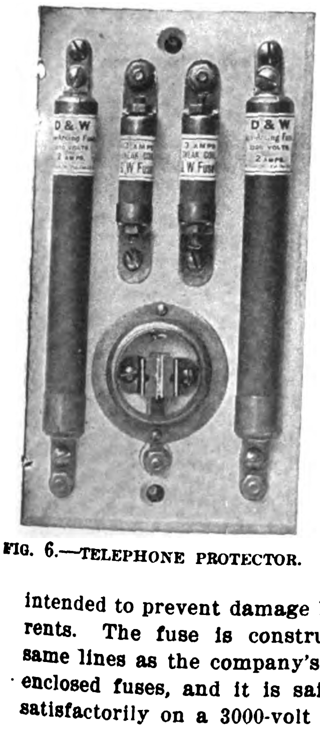


FIG. 6.—TELEPHONE PROTECTOR.

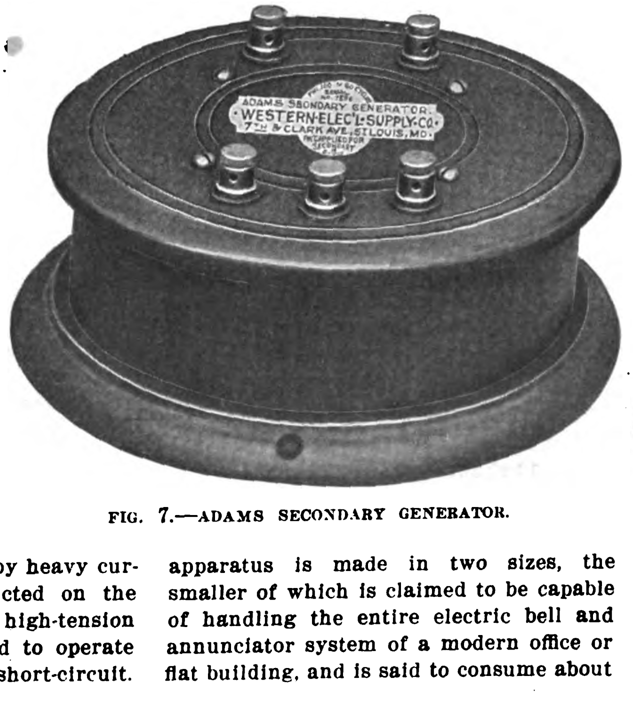

ADAMS SECONDARY GENERATOR.
WESTERN-ELEC'L-SUPPLY-CO.
7TH & CLARK AVE. ST. LOUIS, MO.

FIG. 7.—ADAMS SECONDARY GENERATOR.

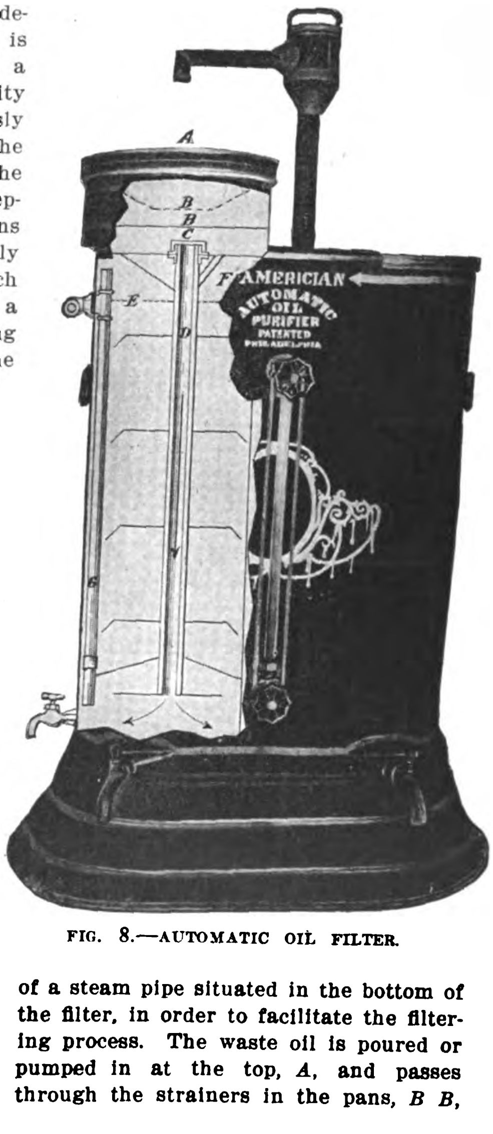


FIG. 8.—AUTOMATIC OIL FILTER.

which take all of the larger impurities from the oil before it passes into the chamber *C*. It then flows through a perforated cap on the top of the tube *D* into the chamber at the bottom, and up through a series of perforated pans, or strainers, to the water line *E*. Here, the manufacturer explains, the purified oil, having been separated by gravity, passes off through an oil overflow at *F* to the storage tank, and the water flows out of the overflow pipe *G* to the sewer. The filter is made of heavy galvanized iron, and the filtering and storage compartments are entirely distinct, so that the removable strainers may be lifted out and the entire purifying or filtering chamber inspected or cleansed without interfering with the other part of the apparatus. Cocks are provided for drawing off the liquids from the different compartments, and the oil tank is also provided with a gauge glass, to show the amount of oil which it contains. The filter is made by the American Oil Filter Company, Philadelphia, Pa.

SIMS STEAM SEPARATOR AND TRAP.

The effects of having a large amount of water entrained by steam that is used for power purposes are very serious, as every engineer knows, and as the number of steam separators and traps in use bear witness. Among the latest types of apparatus designed to eliminate moisture from steam is the separator made by The Sims Company, of Erie, Pa., and illustrated herewith. Fig. 10 is a sectional view and Fig. 9 shows its application on a horizontal pipe. The steam from the boiler follows the path indicated by the arrows. It will be observed that, instead of passing directly through the separator, the steam flows through a series of ports, shown at *F*, and impinges on the curved ribs *A* around the inner chamber. This throws out the water, which trickles into the reservoir *E*, the steam passing out as indicated. A trap automatically opens the outlet valve of the reservoir, allowing the water to discharge itself. In the illustration, *C* and *D* are valves, and *B* is a copper pipe, all of which are connected by suitable rods and levers, as shown. When the water in the reservoir is below the valve *C*, steam is admitted to the copper pipe *B*, which is expanded by the heat in the steam, and in expanding closes the valve *D*. When the water reaches the valve *C*, it fills the pipe *B*, cooling it and causing it to contract and open valve *D*, whence the steam pressure forces out the water. The valve *C* is so adjusted as to allow the water to flow from the expansion pipe slowly, and when the water falls below the level of *C*, steam is again admitted to *B*, and the cycle of operations repeated.

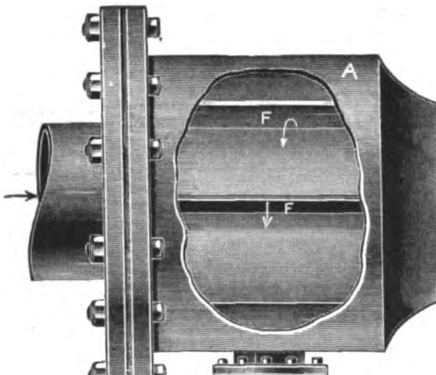


FIG. 9.—STEAM SEPARATOR AND TRAP.

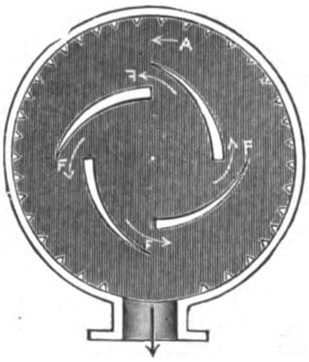


FIG. 10.—SECTIONAL VIEW OF SEPARATOR.

A NEW MOTOR SPEED CONTROLLER.

All users of electric controllers must be aware of the fact that no one design of controller is best adapted to all varieties of service. With this fact in view, The Electric Controller & Supply Company, of Cleveland, Ohio, has added to its line a new design of controller, known as the "Type U," the arrangement and construction of which is adapted to the control of standard cranes and other electrically-driven machinery which is not subjected to excessive overloads. Fig. 11 shows a front view of the "Type U" controller, and Fig. 12 is a rear view of the slate face, showing the resistance units and connections. It will be noted that all of the working parts of the controller are carried by the slate face. The frame, which consists of a single casting, serves simply as a protection and support for the working parts. The removal of two screws frees the face from the frame and permits ready inspection of all the controller connections.

Fig. 13 shows in detail the construction of one of the resistance units. The core of the unit is a rod of soft iron, over which is placed a heavy tube of asbestos. Caps are provided at both ends of the tube for receiving the ends of the resistance winding, the cap at the rear end being of insulating material and that at the forward end being of copper and threaded onto the iron core rod. This core rod is extended beyond the copper cap and passes through the slate face, where it is locked in position by a lock nut working in a counterbored recess. The contact button, which is drop forged from pure lake copper, has a hexagonal head, by means of which it is screwed with a wrench in place on the end of the core. It will be readily seen that by reason of this construction the contact button may be removed and replaced without in any way disturbing the resistance unit or its connections. The iron core rod of the unit serves three purposes; first, it is a conductor from the forward end of the resistance winding to the rear end of the unit, thus bringing all the terminals of the various units into one plane; second, it connects the resistance winding to the contact button, and third, it forms the core of a powerful electromagnet of which

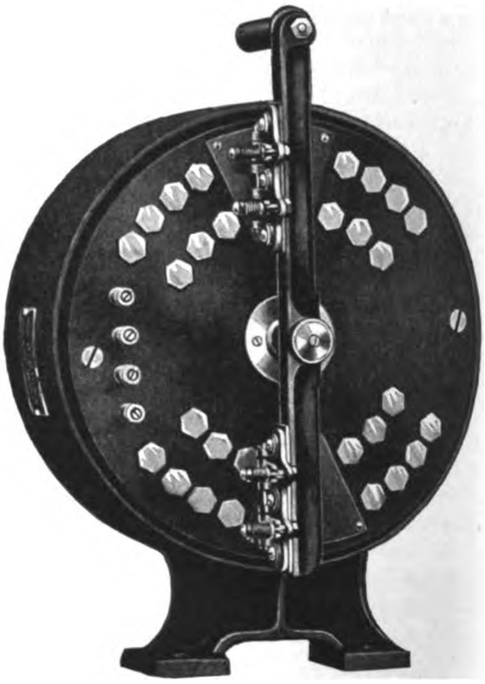


FIG. 11.—FRONT VIEW OF TYPE "U" CONTROLLER.

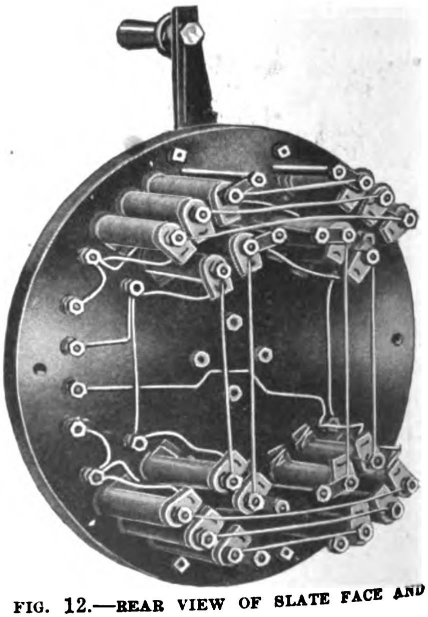


FIG. 12.—REAR VIEW OF SLATE FACE AND CONNECTIONS.

the turns of resistance material form the exciting winding. By this construction each contact is placed in a powerful magnetic field of its own, and an efficient blow-out provided.

The frame is finished with four bosses set ninety degrees apart; consequently, by altering the position of the face in the frame, the controller may be adapted for wall, floor or ceiling support, the operating lever being maintained normally in a vertical position. To give further flexibility, the handle is adapted to be attached to the operating lever in three positions, the one shown in Fig. 11, the corresponding one on the other side of the lever, and screwed directly into the end of the lever, forming a continuation of it.

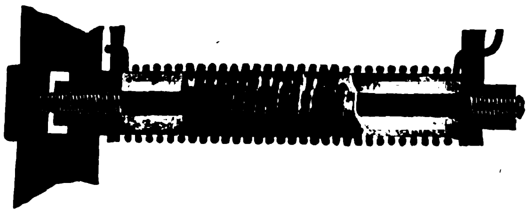


FIG. 13.—DETAIL OF RESISTANCE UNIT.

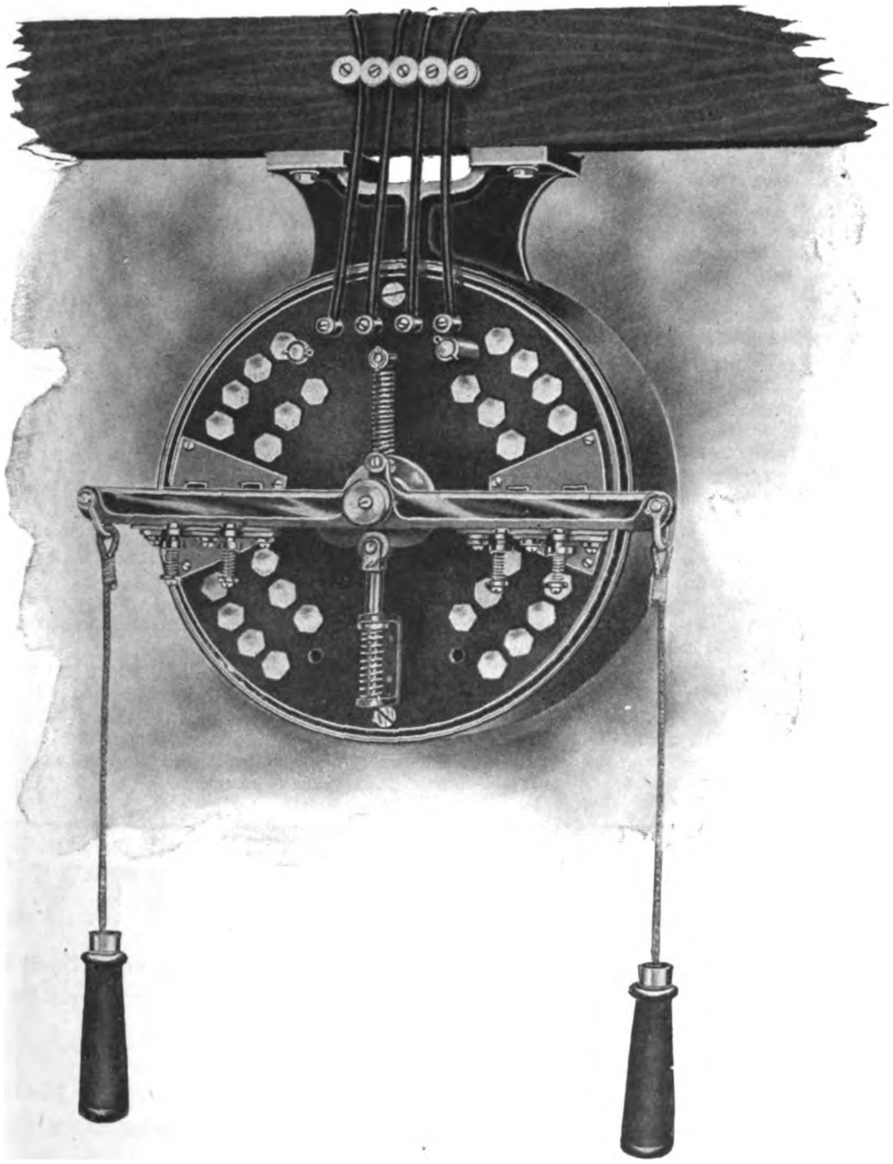


FIG. 14.—SUSPENDED CONTROLLER OPERATED BY CHAIN OR ROPE.

Fig. 14 shows the Type U controller adapted to overhead support and operated from the floor by means of chains or ropes. A powerful spring return is provided which returns the arm to the "off" position when the ropes are released.

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NEW BOOKS.

Copper Handbook. (Second Edition.) By Horace J. Stevens. Houghton, Mich.: Published by the author. Buckram: 416 pages, 5¾ x 8½ ins. Price, $2.

This is the only book that is devoted exclusively to the copper industry, and should be invaluable to those interested in that industry. The author treats the chemistry, mineralogy and metallurgy of copper, and presents statistics concerning the copper deposits and the industry of the world, leading foreign mines, and in full detail the American mines.

Bulletin of the New York Edison Company is the title of an interesting little publication issued monthly under the editorial guidance of Mr. Arthur Williams, the general inspector for the Edison Company. The Bulletin contains, in addition to central station items, a very useful list of wiring and installation contractors in Greater New York and Yonkers.

PERSONAL.

COL. ALLAN C. BAKEWELL, general manager of the Sprague Electric Company, was recently elected vice-president of the Pennsylvania Society of New York.

MR. GEO. D. SIMMONS, formerly superintendent of the Hawks Electric Company, has joined the staff of the Sprague Electric Company's Boston office.

MR. W. R. FABEN, formerly managing director of the Owosso & Corunna Electric Company, has resigned that position to accept a similar one with the Hammond Illuminating Company, of Hammond, Ind.

MR. H. C. SPAULDING, who is well known in electrical circles, has become associated with Sargent, Conant & Co., Incorporated, of Boston, Mass. This company undertakes all classes of electrical engineering in both the railway and lighting fields.

MR. BAILEY WHIPPLE, who has been connected for some time with the Buckeye and Jandus electric companies, Cleveland, Ohio, and has made many friends for both of those companies, has severed his connection with them to accept a responsible position with the Sawyer-Man Electric Company, New York.

MR. G. T. SIMPSON, for many years prominently connected with the electrical interests of Hamilton, Ont., and later on the engineering staff of the Westinghouse Electric & Manufacturing Company, has engaged in electrical engineering in St. Paul, Minn., with headquarters in the Pioneeer Press Building.

MR. JAMES SWINBURNE, the widely-known English electrical engineer, announces that he has entered into a co-partnership with Messrs. W. R. Cooper and G. H. Baillie, with offices at 82 Victoria Street, London, S. W. The new firm will continue and expand the practice in consulting engineering which Mr. Swinburne has established.

MR. THEODORE N. VAIL, formerly general manager of the American Bell Telephone Company, has been elected a director of the American Telephone & Telegraph Company, which company has taken over the American Bell interests. Mr. Vail was for many years progressively identified with the telephone business, and his return to the field is hailed with much pleasure by those interested.

MR. WM. H. BROWNE, who has been for the past six or seven years general manager of the Royal Electrical Company, Montreal, Canada, has severed his connection with that company and engaged in the manufacture of electrical instruments. Mr. Browne is one of the pioneers in electrical engineering, having been connected with the work of building the first electric railway in Richmond, Va., and later associated with the Westinghouse interests at the New York offices.

MR. E. F. PECK, for several years general superintendent of the construction department of the Brooklyn Edison Company, was tendered a farewell reception and entertainment recently by the Consolidated Electrical Mutual Benefit Association, which is largely made up of Brooklyn Edison employees. The entertainment consisted of a high-class vaudeville performance and toward the close of the affair the association presented Mr. Peck with a silver coffee set and a handsome silver loving cup as tokens of appreciation. Mr. Peck goes to Schenectady on the staff of the General Electric Company.

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TRADE PUBLICATIONS.

H-G PULL SOCKETS. Central Electric Company, Chicago.—A pamphlet price list with the latest discounts on this well-known device.

THE EXIDE ACCUMULATOR. The Electric Storage Battery Company.—This is the second edition of the company's catalogue of Exide accumulators and contains the usual class of data and illustrations relating to this form.

RAILWAY MOTOR CONTROLLER. General Electric Company.—This is Bulletin No. 4281, devoted to the Type-M controller, which is a master controller intended for multiple-unit service, the main line connections being made by individual electromagnetic switches.

WHITE STAR FILTERING SYSTEM. Pittsburgh Gage & Supply Company, Pittsburg, Pa.—A finely executed catalogue containing a full description, with elaborate illustrations, of the single and multiple White Star oil-filtering systems, as well as the smaller individual forms of White Star filter.

RENOLD SILENT CHAIN. The Link-Belt Engineering Company, Philadelphia, Pa.—A handsomely-executed catalogue of pocket size, containing a detail description of the Renold chain and numerous engravings illustrating different applications of this excellent power transmitter.

GARTON LIGHTNING ARRESTERS. Garton-Daniels Company, Keokuk, Iowa.—Catalogue No. 35, devoted to the well-known Garton lightning arrester, which is made for every conceivable class of service. The catalogue is of standard size, well executed and profusely illustrated.

BRISTOL'S RECORDING METERS. The Bristol Company, Waterbury, Conn.—Catalogue No. 7, describing the well-known Bristol recording voltmeters, ammeters and wattmeters. The catalogue is finely printed and contains a large number of specimen charts indicating the performance of this type of meter.

RAIL BONDS. General Electric Company.—Bulletin No. 4279, in which is described the G. E. steel-core flexible rail bond. The plug to be inserted in the hole in the rail contains a steel core which is upset at each end so as to give a more secure and permanent retention of the plug in the hole. The bond proper is of flexible copper cable.

FRICTION SENSITIVE DRILL PRESS.—The Knecht Bros. Company, Cincinnati, Ohio.—A pocket-size catalogue containing a very comprehensive description of this drill press, the special feature of which is a pair of cone-shaped friction discs between which a friction roller is adapted to slide. This drill press was described in our issue of January, 1902.

LUNDELL FAN MOTORS. Sprague Electric Company, New York.—Catalogue No. 304, constituting the 1902 edition and describing the well-known Lundell machines. The catalogue is handsomely executed, and as the machines have become universally known, a large portion of the descriptive matter which necessarily formed part of previous editions has been omitted.

TESTING INSULATING VARNISHES. The Sterling Varnish Company, Pittsburg, Pa.—This is a very valuable little book to users of insulating varnishes. It contains complete directions for testing varnishes as to specific gravity, oil and water resistance, corrosion, "slip," penetration and elasticity. The book is being distributed without cost throughout the electrical trade upon application.

PIPE - THREADING MACHINERY. D. Saunders' Sons, Yonkers, N. Y.—This is a very complete catalogue of pipe-threading machines, ranging from a portable machine cutting up to 2 ins. and adapted for hand operation, up to heavy power-driven machines cutting up to 18 ins. in diameter. Small hand pipe cutters, pipe tongs, pipe taps and reamers, machines, taps and dies and kindred tools are also included in the catalogue.

PUMPS. Rumsey & Co., Ltd., Seneca Falls, N. Y.—This is the fifty-third edition of the Rumsey catalogue of hand and power pumps and hydraulic machinery. The line is too diversified to permit of enumeration and too well known to require it. The catalogue is of standard size, substantially and attractively bound in cloth, and contains descriptions and illustrations of subordinate apparatus in addition to the several lines of pumps.

DIRECT-CURRENT DYNAMOS AND MOTORS. Fort Wayne Electric Works, Fort Wayne, Ind.—Bulletins Nos. 1020 and 1021, containing illustrated descriptions of Wood multipolar dynamos and motors, which are built in sizes ranging from ½ to 30 kilowatts. These machines are wound for three classes of speed—moderate, medium and slow. They are of thoroughly modern design and conform in every particular to the latest standard practice.

THE MIDNIGHT SUN. The Sterling Electrical Manufacturing Company, Warren, Ohio.—A pocket-size pamphlet devoted to the merits of the Sterling incandescent lamp, which is now made with the conventional form of loop filament as well as the special spiral filament described at length in our issue of October, 1901. The title of the pamphlet is derived from the front-page illustration, which shows a Sterling "Special" lamp mounted on a tower overlooking the ocean and serving as a beacon.

TRANSFORMERS. The Converse Transformer Company, Pittsburg, Pa.—This is the souvenir catalogue of this company, which, while it has been in existence only a few years, has done some notable work in transformer construction. The engineers who are now connected with this company designed and superintended the building of the transformers for the celebrated Telluride power plant, the e.m.f. of which is 40,000 volts, and the company has recently built transformers for 80,000-volt circuits for The Power Company of Montana.

KEYSTONE HAIR INSULATOR. H. W. Johns-Manville Company, New York.—A pamphlet catalogue of pocket size presenting the merits of this form of heat insulator. Keystone hair insulator is useful not only for insulating heat, but for deadening sound in hotels, apartment houses, lecture rooms and similar buildings. The material is put up in bales 3 ft. wide and containing 500 sq. ft. each. In buildings of moderate cost it is usually tacked on the studding and the weather boarding is laid over it. It is also useful for lining roofs for the protection of attics from extreme heat during the warm season of the year.

TRAVELING ELECTRIC HOISTS. Pawling & Harnischfeger, Milwaukee, Wis.—Although this publication is designated Bulletin No. 7, it is in fact a very complete catalogue, handsomely executed and describing traveling cranes of from 1½ to 5 tons capacity. These machines are supplied with either one or two motors, as required, the single-motor machine being shifted in position by hand drive and hoisting the load by power. The two-motor type has both power hoist and power travel. In addition to the conventional form of overhead crane there are described traveling hoists adapted to traverse single stationary overhead tracks, consisting of the usual I-beam runway.

THE CAGED LION. The Warren Electric & Specialty Company, Warren, Ohio.—This is a finely executed reproduction of an oil painting, the subject being a lion. The picture, instead of being framed in the usual manner, is mounted in a framework behind vertical iron bars, giving a very realistic effect when viewed at some little distance. The connection between the picture and the Warren Company is explained by the company as follows: "As the lion is king of the jungle so is the Peerless manufacturing establishment king of its kind, ready to maintain its position at all times and against all comers." The company is also sending out a handsome steel engraving of the extensive factory buildings in which Peerless incandescent lamps, transformers and fan motors are manufactured in enormous quantities.

BUSINESS NEWS.

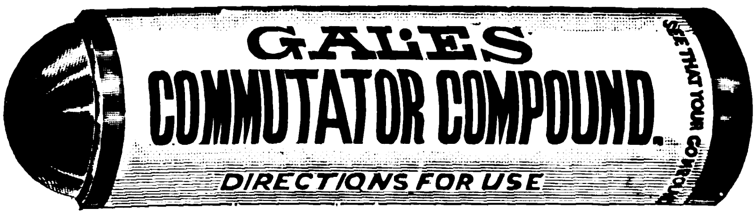
J. H. BUNNELL & CO., New York, have opened a Chicago office in the Monadnock Building, which has been placed in charge of Mr. V. C. Grace.

PITTSBURGH TRANSFORMER COMPANY, Pittsburg, Pa., has opened a New York office at 120 Liberty Street, which will be under the capable management of Mr. A. H. Mustard.

THE CONOVER MANUFACTURING COMPANY has removed its chief business office from 26 Cortlandt Street, New York, to its new factory building on Princeton Avenue, Jersey City, N. J.

LE VALLEY VITAE CARBON BRUSH COMPANY, New York, has removed from 45 Broadway to its new offices and factory at 119 East Forty-second Street, where an absolutely complete stock of carbon brushes will be carried for immediate shipment.

A COMMUTATOR NECESSITY.



The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

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Upon receipt of this coupon we will send FREE, sample stick.

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THE NEW EXCELSIOR DRY BATTERY MANUFACTORY, New York, has removed its headquarters from 108 Greenwich Street to 32 and 34 Vesey Street, where more commodious quarters have been secured.

GEO. T. EYANSON & CO., Philadelphia, Pa., have succeeded to the business of Eyanson & Armpriester in knife switches and switchboards, Mr. Armpriester having retired from the old firm.

THE CUTLER-HAMMER MANUFACTURING COMPANY, Milwaukee, Wis., has purchased the entire block in which its present plant is situated and will add to the plant as rapidly as possible a building with an equipment which will about double its present capacity.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., reports a remarkable increase in the demand for its crane motors and controllers. Several new sizes have lately been added to the line, and the company now supplies machines of this type of from 1 to 60 horse-power.

THE SPRAGUE ELECTRIC COMPANY has found it necessary to secure larger quarters for its Boston office in order to handle the increasing business of that district. The company has therefore taken a suite in the Weld Building, 176 Federal Street. Mr. H. C. Farnsworth will continue as manager of the Boston office.

JAS. McCREA & CO., Chicago, announces that Climax steam joint clamps are now kept in stock by Laib & Co., Louisville, Ky.; Echols-Smith Hardware Company, Birmingham, Ala.; The Fairbanks Company, New Orleans, La., and the Cotton States Belting & Supply Company, Atlanta, Ga.

THE B. & C. ELECTRICAL CONSTRUCTION COMPANY, Utica, N. Y., which was recently incorporated, has elected its officers as follows: E. J. Brown, president; F. B. Chapman, secretary, and V. B. Butts, treasurer and general business manager. The company will deal in electrical supplies and supervise the construction of electrical apparatus.

S. B. CONDIT, JR., & CO., Boston, Mass., recently closed a contract with the Lynn (Mass.) Gas & Electric Company for an alternating-current high-potential switchboard equipped with Elden circuit-breakers and other apparatus manufactured by the Condit Company. This company also secured a contract for a similar board from the North Adams (Mass.) Gas & Electric Company.

THE DAYTON GLOBE IRON WORKS COMPANY, Dayton, Ohio, which supplied the hydraulic machinery for the initial plant of the Royal Aluminum Company, Shawinigan Falls, Quebec, has been awarded the contract for an additional unit consisting of a pair of 59¼-in. wheels to develop 3200 horse-power under a 125-ft. head. This makes the total installation of New American turbines in this plant 9600 horse-power.

THE AUTOMATIC SWITCH COMPANY, New York, suffered considerable loss by fire in its offices and factory on April 14, the damage being such as to necessitate practically new equipment of the main floor of the shop. Steps were immediately taken, of course, to rehabilitate the plant and the company is now in position to supply orders with its usual promptness.

THE GOULD STORAGE BATTERY COMPANY, New York and Depew, N. Y., recently installed a battery of 216 cells in lead-lined tanks and having a capacity of 100 kilowatts at normal discharge rate, to be used for steadying the system of the Amherst (Mass.) & Sunderland Street Railway Company. The battery will be floated on the lines constantly.

FOSTER ENGINEERING COMPANY, Newark, N. J., has received orders recently from the New York Edison Company for a number of combination non-return automatic, emergency and hand-stop valves and several large simple non-return stop valves. The company has also been awarded a contract by the Cleveland (Ohio) Electric Railway Company for a number of 8-in. non-return stop valves.

THE STEPHENSON MANUFACTURING COMPANY, Albany, N. Y., reports a brisk demand for its National automatic cylinder lubricator. In a list of orders recently received were one from the Velvet Mine Company, Ltd., Rossland, B. C., and one from the Wm. R. Trigg Ship Building Company, Richmond, Va. This lubricator is of the automatic force-feed type, and is said to provide absolutely reliable lubrication under all possible conditions.

THE HAINES & NOYES COMPANY, Chicago, recently closed contracts with the Chicago University for a large intercommunicating telephone system and with the American Cotton Company, of Oklahoma City, Wm. H. Taylor Machinery Co., of Allentown, Pa., Frank M. Andrews, Dayton, Ohio, and the George Washington Paint Company, Cleveland, Ohio, for large private telephone systems. The company has also sold a number of telephones to the Metropolitan Elevated Railroad Company, of Chicago, and the United Traction Company, Reading, Pa.

THE HOT SPRINGS ELECTRIC SUPPLY COMPANY, Hot Springs, Ark., has just started in business at the point named, and is in position to furnish dynamos, motors, electric fixtures, Columbia incandescent lamps, and general electrical supplies. The company also undertakes light electrical and mechanical repairing. The manager of the new company is B. E. Holton, who is well known throughout his section.

THE FULLMAN COMPANY, Pittsburg, Pa., announces that the consolidation of the Vulcan Manufacturing Company with the Fullman Company has not resulted in a new organization, as was stated by the daily press. The combination consisted of the merging of the Vulcan Company with the Fullman Company without any change of organization or management whatever in the latter company. The Fullman Company has been in business for a long time and made an enviable record for itself, and the policy which has brought about this result will be continued.

THE SIMPLEX ELECTRICAL COMPANY, of Boston, Mass., some time ago determined to allow its employees to share the profits of the

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Manhattan Rates:
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Means best. Satisfaction guaranteed. No buzzing. Talks clear and distinct. Of neat appearance.

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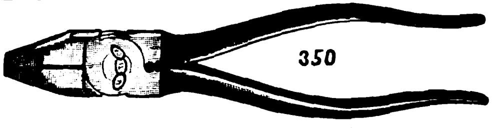

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OUR Swedish Side Cutting and Splicing Plier, illustrated on page 73 of the GREEN BOOK of Hardware Specialties, is made from our Special Brand of Brescian Steel. Toughness and hardness for cutting edge unequaled. Send for Electrical Section.

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An INCANDESCENT LAMP represents a large investment of cap'tal, ingenuity and skilled workmanship, it is sold at a price so low as to necessitate eternal vigilance in cutting costs to a minimum. A successful lamp manufacturer can not afford to experiment with poor materials. This explains the popularity of

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business. The basis on which the men's share was to be reckoned was not clearly understood by the employees, and when the fiscal year expired a few days ago the employees of the company were astounded to learn that $2000 was to be divided among the fifty-two men who have been in the company's employ for the length of time stipulated in the original plan of profit sharing. It is needless to say that the employees are highly enthusiastic both as to the merits of the profit-sharing plan itself and as to the extremely generous policy of their employers.

SAFETY INSULATED WIRE & CABLE COMPANY.—This well-known company, which ranks among the successful manufacturers of insulated wires and cables in the United States, has been acquired by a syndicate formed by Zimmerman & Forshay, bankers of New York City. The company recently acquired large factory and water front properties at Bayonne, N. J., where a full equipment of modern submarine cable machinery has been installed. Mr. Leonard F. Requa, who has been general manager of the company for many years, will continue on the board of directors of the new organization and retain an active interest in the business affairs of the concern.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY will begin immediately the construction of a large addition to its plant at East Pittsburg. The plans for this addition were made two years ago, as the conditions then indicated that such an addition would be imperative within a comparatively short time. Arrangements have been made with the Pennsylvania Railroad Company whereby a special track will be built from East Pittsburg to the new Westinghouse foundries, which are now being installed at the town of Stewart, several miles east of the main shops. This railroad line will be put in for the exclusive use of the Westinghouse companies.

H. W. JOHNS-MANVILLE COMPANY, New York, reports the receipt of the largest order for pipe covering that has ever been placed. This order is for covering for 280 miles of 8-in. oil pipe between Bakersfield and Point Richmond, Cal., the pipe being one of the lines of the Pacific Coast Oil Company. On account of the heavy nature of the oil it must be heated to a certain temperature before it can be pumped, and it was in order to maintain the temperature between the pumping stations that the use of covering was adopted. It is interesting to note that the covering necessary for this stretch of pipe will fill 200 railroad cars. It is also interesting to note that the immense facilities of the Johns-Manville Company enabled it to ship several miles of the covering within a few days after the receipt of the order.

EXHAUST STEAM HEATING.—American District Steam Company, Lockport, N. Y., reports that the subject of exhaust steam heating is being considered to a much greater extent this year than ever before. The company claims to have demonstrated in many instances that the installation of the Holly underground system of exhaust steam heating enables an electric light company to sell its exhaust steam for more than enough to pay all station expenses and interest on the investment in the heating plant. The company is installing a large number of such plants and is also putting in a number of live-steam heating plants. In cities where natural gas was formerly available for heating and the gas has given out there has arisen a strong demand for a district system of heating and this, of course, has contributed to the large increase in business which the American District Company is enjoying.

"BREAD CAST UPON THE WATERS."—The Liberty Manufacturing Company, Pittsburg, has just received an order from Fraser & Chalmers, London, England, for turbine tube cleaners, to which was attached an advertisement published in October, 1900. A day later another order was received from a large firm in New York for turbine cleaners for boiler tubes and for economizer tubes with hose, as the result of an advertisement which appeared more than two years ago. These orders not only show that returns from advertising are likely to continue for some years after the advertisement appears, but that the largest and best firms in New York and London, as well as the humble engineer order from these advertisements.

THE LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, New York, has pushed rapidly to the front during the past year. Like many other telephone manufacturers, the foundation of its business was laid along comparatively small lines. The high character of the apparatus and the conservative methods of the company, however, have had the inevitable effect, so that the company now holds an enviable position as a manufacturer of strictly high-grade goods. The company makes telephones and switchboards for every purpose, from the simplest warehouse system to complete common-battery multiple exchange systems. The factory now has under way a 500-instrument multiple switchboard common-battery system with lamp signals, for the Manhattan Elevated Railway Company, New York. The telephones are to be located at the stations and offices along the road. It is said that many of the instruments will be located fully ten miles from the exchange center, and will average 2000 calls a day. The switchboard will be divided into six operators' positions in order to take care of this exceptionally heavy traffic.

The United States Army, through its Signal Corps, has recognized the high efficiency of Schmidt apparatus, and during the past two years has ordered a large quantity of telephones and several hundred switchboards of the Schmidt special portable army type. These instruments are in use throughout the fortifications in this country and Porto Rico and the Philippines. Naturally in a hot and damp climate such as that of the Philippines, telephone apparatus works under exceptionally severe conditions, but the Signal Corps has yet to make the first adverse criticism of the service performed by these instruments.

BOOKS.

SLIDE VALVE Instruction Chart....... $ .25
CORLISS ENGINE Chart of Values, &c. .25
ALGEBRA Self Taught.................. .60
THE MODEL ENGINEER............. .08
SMALL Accumulators.—Marshall......... .50
ELECTRIC GAS LIGHTING.—Norrie. .50
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All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

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WARREN'S PULLEY COVER

Should be on every dynamo and alternator pulley. It positively overcomes belt slipping.

THE PROOF!

Repeated re-orders from users of power everywhere. We send first orders on trial, to be paid for only if satisfactory. We want you to give it a trial. Write for particulars to-day. Accept no substitute.

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THE WARREN COMPANY, Inc.
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ARE THE WORLD'S STANDARD VALVES

For automatically reducing and absolutely maintaining an even steam or air pressure.

They are adapted for every need and guaranteed to work perfectly in every instance.

Write for full information and splendid references.

THE MASON REGULATOR CO. Boston, Mass., U. S. A.

American Electrician.

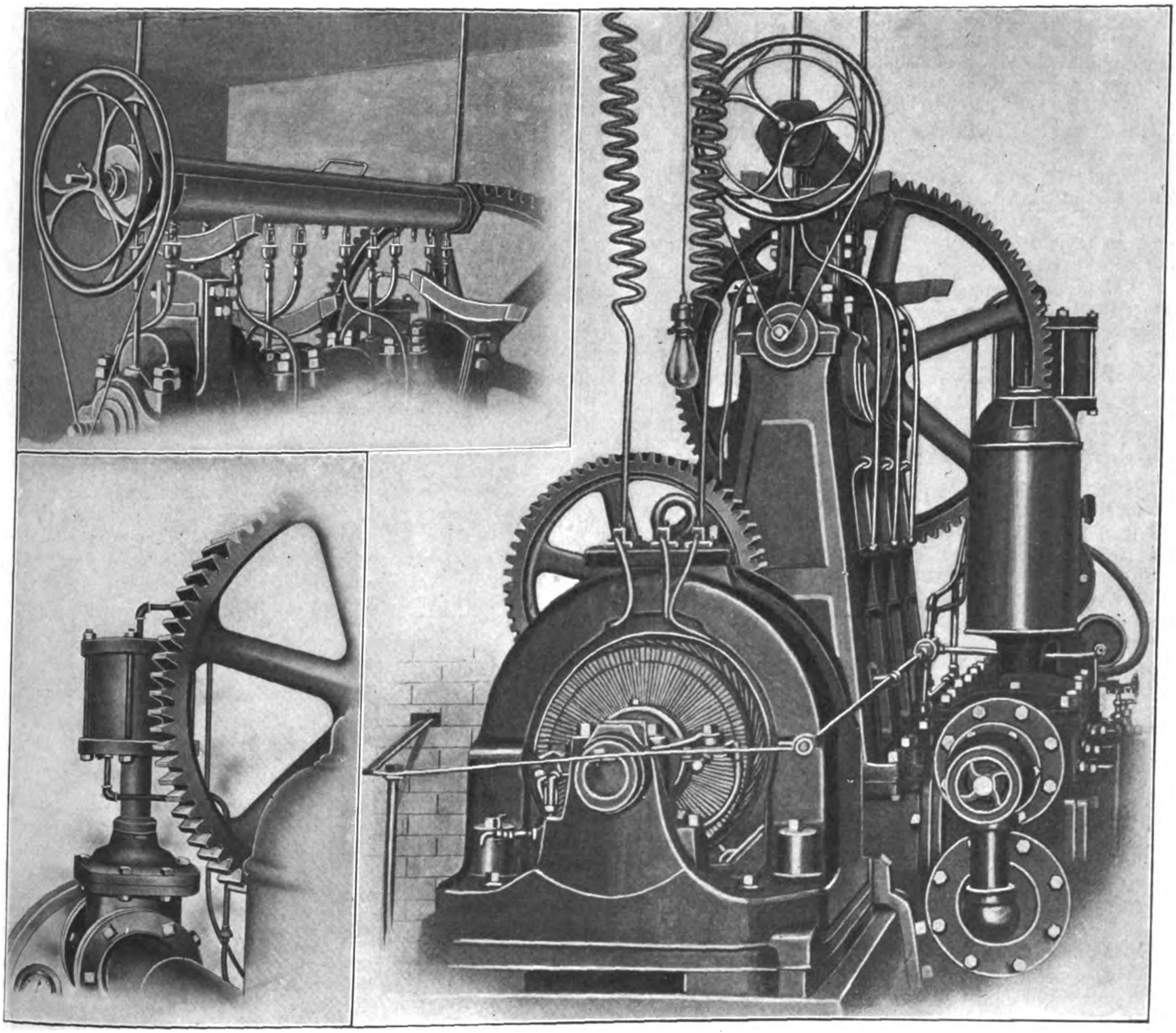
Vol. XIV. New York, June, 1902. No. 6.

A PROGRESSIVE AND PROFITABLE SMALL CENTRAL STATION.

THE WHITEHALL ELECTRIC COMPANY'S PLANT.

BY J. R. CRAVATH.

It is coming to be so commonly considered that the electric light plant in the small town is at best a precarious and unprofitable investment, and having open to it no means of materially increasing its revenue beyond that received from the ordinary consumption of electric light, that it is refreshing to find a central station in a town of 2,100 population which is awake to the possibilities of the business and is furnishing not only electric light, but electric power for turning all the wheels in the community. The Whitehall (Ill.) Electric Company has probably developed the possibilities of the central station business in the small town to a greater extent than any other company of its kind in the country. Although it has been urged for a number of years by the writer and by others that it is quite practicable for small electric light companies to furnish power for every purpose in the community, and that they are in a position to do this cheaper than it can be supplied in any other way, but little progress has been made in this direction by small companies. The example of the Whitehall Electric Company serves to furnish practical evidence as to the feasibility of the ideas which have been urged, and an account of this company's work should serve to stimulate other small companies to like endeavors and to suggest a way in which small electric light plants which are losing money, or are doing little



FIGS. 1, 2 AND 3.—PUMP AT THE WATER WORKS, AND SOME DETAILS.

better than making expenses, may be put on a reasonably paying basis.

The plant at Whitehall has a number of features, any one of which would be sufficient to command interest and attract an investigation of the plant. In the first place the company is giving an all day service, which in itself is something remarkable for a town of 2,100 people, since many plants in villages of this size give only service from dark until midnight. Secondly, the company is supplying a single-phase power service along with its electric light business, which is also unusual both in large and small towns. In the third place, this company is pumping all the water for the city by means of an electrically-driven pump located one mile from the electric light station and operated without any attendant at the pump house. And, finally, the company is furnishing practically the entire community with power; the mechanical operation of all the industries in the town is dependent upon the electric light company. From this brief statement it will be seen that this company is living up to its opportunities to the fullest extent, and it will also be gratifying, as well as of value to investors in small electric light stations, to know that its enterprise is being rewarded by a reasonable profit on the investment, with sufficient surplus to maintain and renew equipment as needed, as well as to make such extensions of service as may be necessary. This was not done without hard and intelligent work on the part of the two men most interested in the success of the company, but it has been done, and the results stand for themselves.

The present plant is fortunate in being incumbered very little with out-of-date apparatus, as it was started about six years ago. However, there are some traces of an unsuccessful experiment on the part of would-be revolutionists of the electric light business who first undertook electric lighting in Whitehall. It is not necessary here to go into the original plans of the Whitehall company before the present management took hold; it will suffice to say that these plans included among other things a 220-volt constant-potential system of underground distribution with wires pulled through gas pipes filled with oil—in a town of 2,100! The present management took hold about the time the failure of this experiment was apparent and an entirely new plant on lines of tried and approved practice was installed, the only variation from common practice being the use of a 220-volt, constant-potential, direct-current dynamo for furnishing arc light. This dynamo was, of course, an inheritance from the first régime.

The present generating plant consists of one 60-cycle, Westinghouse, single-phase alternator, of 60 kilowatts capacity, with a composite-wound field. This machine delivers current at 2,200 volts and is belt-driven at 900 r. p. m. by a 12-inch x 12-inch simple, high-speed engine, made by the Fischer Foundry & Machine Company, of Pittsburg; the engine runs at 250 r. p. m. This unit supplies all incandescent lighting and power. Arc lighting is supplied by means of a 50-h.p. Westinghouse simple engine direct-connected to the 220-volt direct-current dynamo. The arcs are operated four in series across the 220-volt mains. Separate half-circuits are run from the power-house for each series of four, and a single common return wire is used for all circuits. The arc lamps are operated only on nights when there is no moonlight, and then up to midnight only.

The boiler equipment consists of two boilers 14 feet long by 5 feet in diameter, made by the O'Brien Boiler Company, of St. Louis. These boilers are fed by a Battle Creek internal condensing pump and also in case of emergency by an injector. In the matter of feed water the company is very fortunate as the water used leaves practically no scale whatever. A practice somewhat out of the ordinary in the setting of boilers is that of leaving no large chamber behind the bridge wall for the collection of soot and ashes. The floor of the combustion chamber is brought up very near the level of the bridge wall and the ashes are cleaned out, not by removal from the back of the boiler setting, but by shoving them towards the bridge wall and removing through the grates. The back of the boiler setting forms one wall of a neat store, office, and repair room. The coal burned is a good grade of Illinois slack, which costs delivered a maximum of 75 cents per ton. During the earlier part of the evening two boilers are fired up unless the incandescent load is light, as on Sunday evening, when one boiler will do the work; during the remainder of the 24 hours but one boiler is worked.

The situation of the station building is excellent. It lays between the Chicago & Alton and the Chicago, Burlington & Quincy Railroads, so that coal can be obtained from either road. On each side of the station is a siding and coal bin for coal supply from the railroad on that side. To get coal in front of the boilers, which are midway between the two coal bins, there is a track laid straight through the boiler room from one coal bin to the other, and a small tram car, having a carrying capacity of 1,500 pounds. One side of the car is left off so that the firemen can shovel direct from the car to the fire, the distance from the edge of the car to the furnace door being 6 ft. 3 ins. All valves in the plant are placed where they are easily accessible, both for repairs and for ordinary use.

The alternator is run on week days the entire 24 hours except for one hour at noon. On Sunday it is shut down during the daylight hours. The power load at present consists of one 25-h.p. motor at the waterworks pump house; one 25-h.p. motor in a pottery; two 10-h.p. motors in a pottery; one 10-h.p. motor in a grain elevator; one 2-h.p. motor in a printing office; one 1/8-h.p. motor driving a deep-well pump; two ¼ h. p. motors running static machines in physicians' offices; one 1/8-h.p. motor running a static machine; one 1/6-h.p. machine running an air compressor for a dental chair, and two dental motors. All of these are single-phase machines. From this it will be seen that over 70 horse-power in single-phase motors is connected.

Perhaps the chief interest centers in the plan of pumping water for the town, not only on account of the possibilities of similar work elsewhere, but because of the engineering difficulties that have been overcome. Although the water tank for town supply is located close to the electric light station, the pump house is just one mile from the station at a reservoir in the country. As one of the objects in using electric power for pumping was to save labor, it was, of course, out of the question to place an attendant at the pump house. Some scheme had to be devised for safely starting and operating the pump from the central station. This has been very successfully accomplished, and the pump has been in operation since December 1, 1899, with only two interruptions, neither of which was due to anything peculiar to this equipment.

At the pump house is a 25-h.p. Wagner motor wound to operate at 208 volts. This is supplied by a 25-kw. transformer, which reduces the line voltage of 2,200 to the motor voltage. The only electrical apparatus at the pump house besides the motor and transformer are the fuses in the primary and secondary circuits, and a double-pole switch in the secondary circuit. The motor runs at 1,200 r. p. m. and is geared to a Smith-Vaile triplex pump, as indicated in Fig. 1. The capacity of this pump is 15,000 gallons per hour, at 83 r. p. m. The frame of the motor is insulated from the base with hard fibre, and the pinion is of rawhide. To produce a practical apparatus out of this combination and one which would be suited to the conditions, Mr. W. A. Winn, superintendent of the Whitehall Electric Company, had to accomplish two things which were not accomplished by the apparatus as furnished by the manufacturers. First, there had to be an automatic oiling of all parts and the oil supply had to stop when the pump stopped, to prevent waste of oil. Second, there had to be means of allowing the single-phase motor to start free so as to avoid excessive starting currents which might overload the generator at the power-house and might also injure the motor. The first problem was solved in a very ingenious way. At the top of the machine was placed a long covered oil trough, of cylindrical shape, as shown in Fig. 2. Through the axis of this cylindrical trough there is a revolving shaft which is driven by a sewing-machine belt from one of the pump shafts. This shaft carries fingers or arms, on the ends of which are pieces of felt wicking, and tubes for conducting the oil to the various bearings about the pump terminate in the top part of the oil trough in such a position that every time the shaft revolves an oil-saturated wick touches the end of each tube and deposits oil in it. When the pump stops of course the shaft stops, and no more oil is delivered to the tubes. A few of the main bearings of the pump are of the ring-oiling type.

Arranging to allow the motor to start without load was a more difficult proposition. Those familiar with the volume of starting current taken by single-phase motors, even when starting free, can imagine what would be the results of starting a motor geared to a pump, that must get under motion a horizontal column of water a mile long under a head of 160 feet. To start it suddenly would, of course, be out of the question; a by-pass from the pump discharge must be opened in starting. In devising means for automatically opening a by-pass so that the pump might start free, Mr. Winn was aided by the peculiar construction of the Wagner single-phase motor. This motor, as most of the readers of

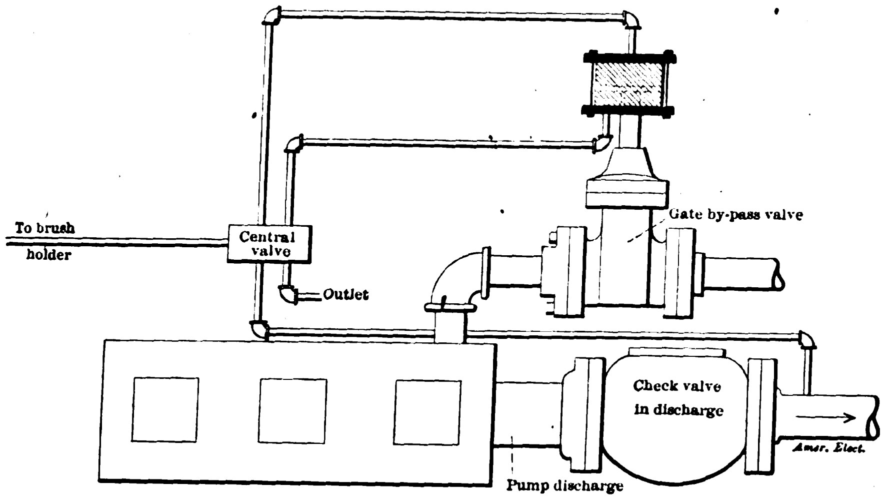


FIG. 4.—CONTROLLING MECHANISM OF PUMP.

this article probably know, is provided with a starting commutator and brushes. These brushes bear on the commutator when the motor is at rest and while it is first starting. After a certain speed has been attained a centrifugal governor on the armature shaft acts to throw the brushes off the commutator and short circuit the commutator bars with a solid copper ring. This governor is very positive in its action, and brings the brushes off the commutator with a snap when the proper speed is attained.

Under the present arrangement, in order to start the motor the man at the central station simply throws a double-pole switch which connects the motor feeder to the bus-bars. The discharge of the pump is provided with a by-pass valve which, when open, allows the pump discharge to flow directly back to the reservoir with no pressure. The pressure from the water-works tank and main is kept from the pump by an ordinary check valve in the discharge. This by-pass valve is of the gate type, and is operated by a small hydraulic cylinder and piston. As soon as the motor gets up to speed, the same action of the governor which throws the brushes off the commutator moves a valve which controls the supply to the hydraulic cylinder. The piston then proceeds to slowly close the by-pass valve, and as soon as this by-pass is sufficiently closed the pump begins to work against the pressure in the mains. The small hydraulic controlling valve is worked by a rod and lever connected mechanically to the brushes of the Wagner motor, as indicated in Fig. 4.

In order to prevent any possibility of water spurting from the plungers of the triplex pump onto the motor, the usual opening in the pump casting on the side towards the motor has been closed with sheet iron. When the pump motor is first thrown on the ammeter in the pump house, the circuit shows a maximum of about 9 amperes at [illegible] volts; the current when pumping is from 7½ to 8½ amperes. The great inertia of the water in the mile of pipe between the pump house and the elevated water tank near the power-house is made evident every time the pump stops. The tank, when full, gives a hydraulic head of 114 feet measured from the ground. When the pump is stopped the gauge in the discharge pipe of the pump immediately goes to zero and stays there several seconds, showing that the inertia of the water between the pump house and the tower is sufficient to force it against the full head of water, leaving for a time no pressure at the pump house. When the inertia of the water has been spent the column comes back against the check valve in the discharge of the pump with enough force to drive the gauge around to 160 pounds.

The height of water in the water-works tank is indicated by a pressure gauge in the boiler room. The pressure gauge showing the pressure of water has a high and low water alarm attachment by which an electric bell is sounded whenever the pressure exceeds or falls below the proper limits. In this connection it might be mentioned that there is a telephone line between the pump house and the central station.

The company receives from the town $75 a month for pumping 80,000 gallons of water per day. This 80,000 gallons is the capacity of the tank, and if the tank has to be filled more than once a day the town pays for any additional pumping at the rate of 3 1/8 cents per 1,000 gallons, which is about the rate paid for the regular pumping. Interruption to the water works pumping has been of practically no importance as regards the city supply. On one occasion something happened in connection with a severe wind and lightning storm which caused the burning off of both the 2,200-volt wires to the pump house. This, of course, was easily and quickly repaired within an hour from the time it occurred. On another occasion the fields of the pump motor burned out at 1 a. m.; the coils were taken out at once, sent to St. Louis on the next train for renewal, and on the following morning at 4 o'clock the motor was in service again.

Next of interest after the water-works pumping is the use of motors in potteries. The clay industry is the principal one at Whitehall, as the town is underlaid with excellent potter's clay. As indicated by the list of motors, a large proportion of the power used during the day is taken by the potteries. In the case of one 25-h.p. motor in a pottery the load was very unsteady as the motor was driving clay-crushing machinery; the variation of load due to this amounted to about six horse-power and occurred between two and three times a minute. When this motor was first installed it had a very disastrous effect on the voltage regulation of the entire system. This trouble was decreased by heavy fly wheels on both the motor shaft and the countershaft it drives, and what remained was overcome entirely by the use of a Chapman voltage regulator applied to the alternator. Some of these pottery motors are only operated a part of the year. They are all of the Wagner automatic-starting type.

The motor mentioned in the list as operating the deep-well pump is at a private residence, which is located beyond the town water mains. This is an Emerson machine geared to a crank which works the plunger of the pump and the plunger is counter-balanced by a weight on the end of a rope running over two pulleys in the roof of the pump house, after the manner of an elevator counterbalance.

The incandescent load can be judged from the ammeter readings plotted in the daily output curve. During the day but few incandescent lights are used save in the potteries, and in the evening the motor load is practically negligible. As the plant is not provided with an indicating wattmeter there is no way of knowing the actual output in watts from hour to hour. About 1,500 incandescent lamps are wired up. Excellent judgment has been shown in the purchase and location of transformers, as can be seen from the following very brief list of transformers in use for light and small power. Near the center of town are three 200-light transformers and the balance are as follows: one 100-light; one 60-light; two 40-light; four 20-light; four 10-light, and one 5-light. The number of lights in use during the heaviest load in winter is but

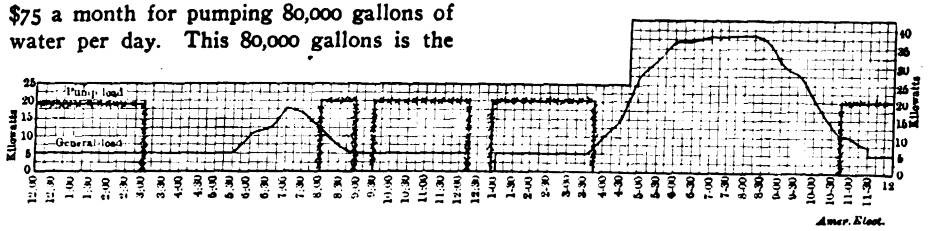


FIG. 5.—LOAD CURVES FOR DEC. 20.

little more than 1/3 the total number wired up.

For power purposes there is the 25-kw. transformer at the pump house; two 20-kw. transformers in a pottery; one 10-kw. transformer in an elevator and one 10-kw. transformer in a pottery.

The rates to all customers on meter is 15 cents per kilowatt hour with a minimum charge of a dollar per month and no discounts. There are 73 meters connected on the system, of which 10 are in stores. Twenty stores and twelve residences are on a flat rate basis. Flat rates for stores are 50 cents a month per 16-c. p. lamp. For residences the flat rates are as follows: two lamps, $1 per month; three lamps, $1.40; four lamps, $1.70; five lamps, $2; six lamps, $2.20; seven lamps, $2.40; eight lamps and up, 15 cents per lamp. Rates for small motors are the same as for incandescent lamps, as the small motors are connected on the lighting circuits. Special contracts are made with large power users. One pottery has 35 horse-power in motors installed and is operated on an independent circuit from the power-house so that record can be kept of its service. Motors on meter pay 15 cents per kilowatt-hour.

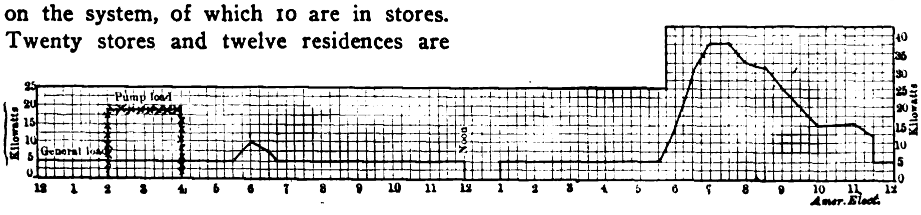


FIG. 6.—LOAD CURVES FOR MARCH 20.

A few constant-potential alternating arc lamps are in use, there being three 4-ampere enclosed arcs, and one 6-ampere lamp. The 27 street lights are Western Electric constant-potential open arcs, operated four in series with a slight additional resistance in each circuit at the station. The primary 2,200-volt lines are all fused with Pass & Seymour enclosed fuses; branch primary lines are fused this way on the pole.

Some thought is being given to a change to series alternating arc lamps. If these were used it would do away with the necessity of running two engines and two boilers much of the time, and of course would save some coal, though the saving of labor over existing conditions would be very small. In the actual operation of the plant two men are employed, one for the night and one for the day run. In addition to this Mr. Winn, the superintendent, gives the business his entire time, and an apprentice boy is sometimes employed at nominal wages.

Everything about the plant is kept in first-class shape, and all the construction work is neat and thorough. In order to give the continuous service for light and power which this company has offered for some time past the most careful attention to all details is required, and the maintenance in first class shape of the one unit upon which dependence is placed. Although it is generally considered unsafe to attempt to give a continuous light and power service upon which much depends with but one generating unit, it must be recognized that a great deal depends on the men in charge of the apparatus, and that a single unit in charge of a superintendent who is a careful and business-like mechanic is much better than many units carelessly handled. The service from this plant has always been such that the people have come to depend absolutely upon it and their confidence in its reliability has never been shaken. The plant is arranged so that in case of trouble to the engine which drives the alternator, the latter machine could be quickly moved over and belted to the Westinghouse engine which drives the 220-volt dynamo. In this way the more important part of the load could be carried over an emergency.

The success of this little plant is due chiefly of course to the ability of its superintendent, Mr. Winn, who possesses the unusual combination of business foresight, natural engineering judgment and practical mechanical skill.

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THE SINGLE-PHASE INDUCTION MOTOR.

BY A. S. M'ALLISTER.

Though the Patent Office records show that some thought is being expended on the subject of polyphase lighting, both arc and incandescent services remain to-day essentially single-phase loads. Where lighting is supplied from power circuits the scheme of dividing the lighting load as equally as may be among the several phases is followed, and where a proper disposition of circuits is made this gives satisfactory service. Where power is supplied from lighting circuits, resort must be had to motors adapted to operate on single-phase systems.

While under no condition is the single-phase motor more satisfactory or economical than the polyphase machine, yet, by a little care in the selection of a motor for the service required, the performance of the single-phase machine may compare quite favorably with that of the polyphase type. The most prominent difference between the single-phase and the polyphase motor is the inability of the former to exert a torque at standstill. Numerous devices have been applied to render single-phase motors self-starting, which have met with varying success. A difficulty which the designer has had to encounter lies in the fact that, with almost no exception, such devices are applicable only to motors of small sizes, or where efficiency is of small moment. Little trouble is experienced in designing self-starting, single-phase motors for meter or fan work, but the problem assumes a different aspect when motors for power purposes are desired.

In what follows, an attempt will be made to outline the characteristic features of the single-phase induction motor, to ascertain the similarities and the differences between the performance of a single-phase and that of a polyphase machine, and to investigate the methods by which the single-phase motor may be operated under various conditions.

Although supplied with current, which, if acting alone, could produce only a simple alternating magnetism, in contradistinction to a rotating field, it is found that a single-phase motor under operating conditions develops a rotating field essentially the same as would be obtained were the machine operated on a polyphase circuit. The effect of the mechanical motion of the secondary in producing the rotating field may be determined as follows:

Assume for purpose of illustration a motor with four mechanical poles having the two opposite poles excited by a single-phase alternating current, and consider the moment when one of these poles is at a maximum north and the other a maximum south, as shown in Fig. 1. If the rotor be moving across this field in the direction indicated, there will be generated in each of the conductors under the poles an e. m. f. proportional to the product of the field magnetism and speed of rotor. Evidently if the speed be constant, of whatsoever value, this e. m. f. will vary directly with the strength of magnetism; that is, it will be maximum when the magnetism is maximum, and zero at zero magnetism. Other conditions remaining the same, the maximum value of the secondary e.m.f. will vary directly with the speed of the rotor.

If the circuits of the rotor conductors be closed, there will tend to flow therein currents of strengths depending directly upon the e. m. fs. generated in the conductors at that instant and inversely upon the impedance of the rotor conductors. The somewhat unique condition of e. m. fs. in a combined series and parallel circuit, which exists in the rotor as here described, is depicted by analogy in Fig. 2, where the e. m. f. in each conductor across the rotor core is represented by a battery. The absolute value of each e. m. f. depends upon the strength of the primary field and the position of the conductor in that field, and hence changes from instant to instant. The current which flows through the end rings changes its direction of flow with reference to the field

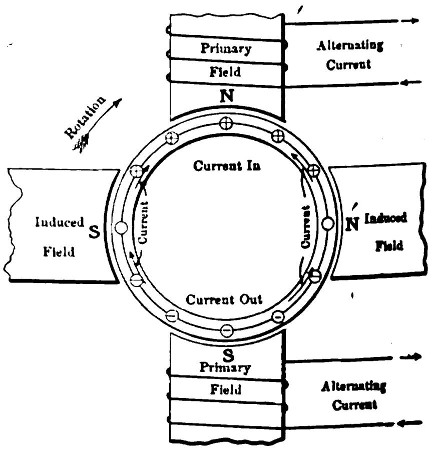

FIG. 1.—PRODUCTION OF ROTATING FIELD.

poles once for each reversal of the primary magnetism.

The current which flows through the rotor circuits at once produces a magnetic flux which, by its rate of change in value generates in the rotor conductors a counter e. m. f., opposing the e. m. f. that causes the current to flow, and of such a value that the difference between it and this e. m. f. is just sufficient to cause to flow through the impedance of the conductors a current whose magnetomotive force equals that necessary to drive the required lines of magnetism through the reluctance of their paths. Since this latter magnetism must have a rate of change equal (approximately) to the e. m. f. generated in the rotor conductors by their motion across the primary field, and since this e. m. f. is in time-phase with the primary field, it follows that this magnetism must have a value proportional to the rate of change of the primary magnetism, and, if the primary magnetism follows a sine curve of values, this magnetism must follow the corresponding cosine curve; that is, it must be in quadrature to the primary magnetism as to time phase.

Consider the "N" pole due to primary magnetism at its maximum strength, and decreasing in value. The e. m. f. generated in the rotor will tend to send lines of force at right angles to the primary field, inducing a secondary N pole at the right (see Fig. 1). The lines of secondary magnetism (induced field) continue to increase in number so long as the primary magnetism does not change *direction* of flow. They, therefore, reach their maximum value when the primary magnetism dies down to zero, at which instant the induced or secondary magnetism will have its maximum strength with the north pole to the right, as drawn.

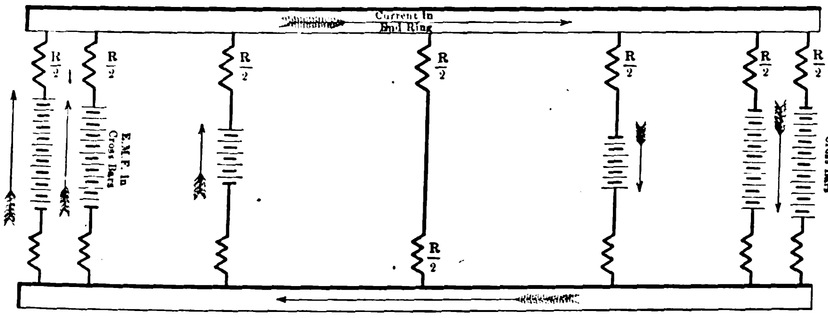

FIG. 2.—E.M.F. AND CURRENT IN SQUIRREL CAGE SECONDARY.

As the primary magnetism now shifts its north pole to the bottom, the secondary lines begin to decrease in number and will reach their zero value when the primary magnetism reaches maximum strength. The induced magnetism will then begin to increase its lines in the reverse direction, producing a north pole to left, and will reach its maximum strength when the primary magnetism dies down to zero again. When the primary magnetism shifts its north pole back to the top, the secondary magnetism will begin to decrease, then finally build up with its north pole to the right again, and so on.

The north magnetic poles produced on the motor thus reach their maximum in the following order: top, right, bottom, left, etc., or in the direction of rotation. Further consideration will show that, had the rotation been taken in the opposite direction, the poles would have travelled in the opposite direction also.

It must be remembered that the simultaneous existence of magnetic fluxes at right angles in the same material is entirely imaginary. The effect of each is, however, real and the existence of the resultant is real.

When the rotor is travelling at synchronous speed, the e. m. f. generated in the secondary conductors by their motion across the primary magnetism is of such a value as to require the induced field (quadrature magnetism) to be equal in effective value to the primary field. If the maximum value of the primary field be taken as unity and time be denoted in angular degrees, then the instantaneous value of the primary magnetism may be represented by cos. *a*, where *a* measures the angle of time from the instant of maximum primary magnetism. In a similar manner sin. *a* may represent the instantaneous value of the quadrature magnetism.

These two fields are located mechanically 90 degrees from each other. Fig. 3 indicates the manner in which the fluxes of the two fields vary from instant to instant, and the position of the resultant core magnetism at each instant, a two-pole motor, with a ring-shaped core without projecting poles, being assumed.

$\overline{OB} = \overline{OC}$ cos. a = value and position of primary magnetism after the time lapse a.

$\overline{OA} = \overline{OD}$ sin. a = value and position of induced magnetism at same instant.

$\overline{OC} = \sqrt{OB^2 \times OA^2}$ represents the resultant field, both in value and position. The point *P* describes a circle. Without further proof it is evident that, neglecting the effect of local impedance in the secondary circuit, there is produced a revolving field of constant intensity when the rotor revolves at synchronous speed.

When the rotor speed is not truly synchronous, the extremity of the vector *O P*, which represents the value and position of the resultant field, describes an ellipse. For any given effective value of primary field magnetism, the effective value of the induced field magnetism depends directly upon the speed as mentioned above. Let *S* represent the speed in per cent of synchronism, then, if cos. *a* represents the instantaneous value of primary magnetism, $S \times$ sin. *a* equals the instantaneous value of the induced magnetism.

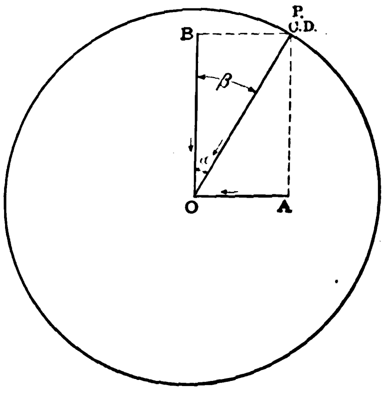

FIG. 3.—CIRCULAR ROTATING FIELD.

Referring now to Fig. 4, after any time lapse, *a*,

$\overline{OB} = \overline{OC}$ cos. a represents the instantaneous value of primary magnetism.

$\overline{OA} = S \times \overline{OC}$ sin. a represents the value of secondary magnetism, while

$\overline{OP} = \sqrt{OB^2 + OA^2}$ represents the value and position of the resultant magnetism.

Since, from the figure, the distance *B P* bears a constant ratio of *S* to distance *B C*, the locus of the curve described by the point *P* is an ellipse.

The vertical axis of this ellipse is determined by the primary field, while the horizontal depends upon the speed. Above synchronism the figure remains an ellipse, having its major axis along the induced field line. At synchronism the ellipse becomes a circle, as noted above. At zero speed the ellipse is a straight line, which means that at standstill there is no quadrature flux and hence no revolving field. Below zero speed, that is, with reversed rotation, the curve is yet an ellipse, the side which was previously to the right being transferred to the left and *vice versa*.

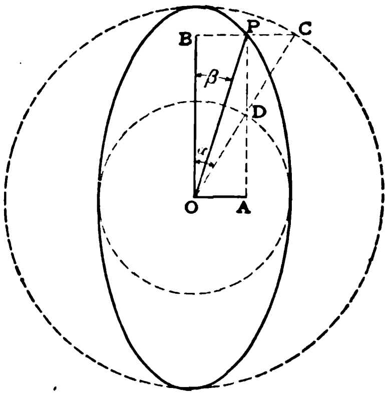

FIG. 4.—ELLIPTICAL ROTATING FIELD.

For the above reasons, the single-phase induction motor has inherently no starting torque whatever, but will accelerate almost to synchronism if given an initial speed in either direction, and, when the torque is not too great, will operate in a manner quite similar to that of a polyphase induction motor.

Due to the existence of the quadrature flux, to produce which magnetomotive force must be supplied by current in the primary windings, at synchronism the magnetizing current for a single-phase motor is twice as great per phase as is the case when the same machine is properly wound and operated on a two-phase circuit of the same e. m. f.; but the total number of exciting ampere-turns is the same in the one case as in the other. A difference in the performance of a single-phase from that of a polyphase motor is found in the existence at no load of considerable current in the secondary with the former, while the rotor current is practically negligible with the latter.

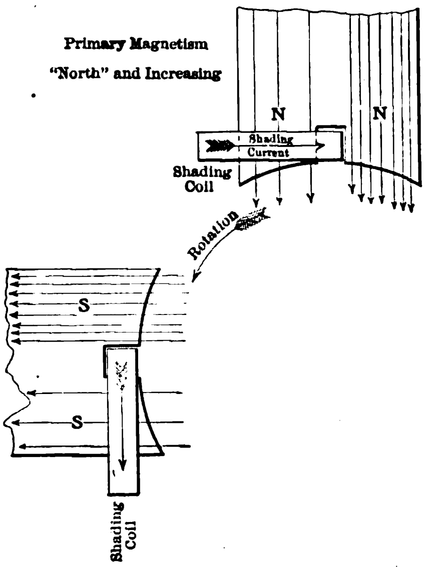

FIG. 5.—ACTION OF SHADING COILS.

The most serious defect in the behavior of single-phase motors is in connection with their lack of starting torque, to remedy which many ingenious devices have been developed. A simple method of producing the requisite quadrature magnetic flux for the purpose of giving a single-phase induction motor a starting torque is found in the use of "shading coils," which are extensively employed in alternating-current fan motors. Each coil consists of a low resistance conductor surrounding a portion of a field pole. As ordinarily applied, there is cut in each pole a slot parallel to the shaft of the rotor. In this slot is placed the conductor, which is connected by a closed path of high conductivity around a portion of the pole included between the slot and the side of the pole, as shown in Fig. 5. The coil of each pole is placed similarly to that of the other poles, and, as explained below, the secondary revolves in the direction from that portion of a pole not surrounded by a coil towards the "shaded" side of the pole.

The action of the shading coils is as follows, reference being had to Fig. 5: Consider the field poles to be energized by single-phase current, and assume the current to be flowing in a direction to make a north pole at the top. Consider the poles to be just at the point of forming. Lines of force will tend to pass downward through the shading coil and the remainder of the pole. Any change of lines within the shading coil generates an e. m. f., which causes to flow through the coil a current of a value depending on the e. m. f. and always in a direction to oppose the change of lines. The field flux is, therefore, partly shifted to the free portion of the pole, while the accumulation of lines through the shading coil is retarded. However, so long as the magnetomotive force of the field current is of sufficient strength and in the proper direction, the lines through the shading coil increase in number, although the increase is retarded, which is to say, that, even after the lines in the other part of the pole begin to decrease in number, the flux within the shading coil is increasing and continues to increase till the exciting current drops to a strength just sufficient to maintain that density of flux which is within the coil. At this instant the flux in the shading coil has its maximum value as a north magnetic pole.

As the flux on the other portion of the pole continues to decrease, the lines within the shading coil tend to decrease also, but the e. m. f. generated by their rate of change causes to flow a current which tends to prevent any change of lines, so that when the other portion of the pole contains no lines whatever there is yet within the shading coil an appreciable amount of flux, forming a north magnetic pole, as indicated by Fig. 6, the result being a shifting of the field from the unshaded to the shaded side of each pole. This is repeated when the magnetism reverses. The lines within the shading coil decrease, with an increasing rate of change, and a condition of zero lines within the coil is soon reached. At this instant, there is a south magnetic pole at the "unshaded" end of the top field pole, and a north magnetic pole at the "unshaded" end of each adjacent field pole, and south and north magnetic poles begin immediately to form within the corresponding shading coils.

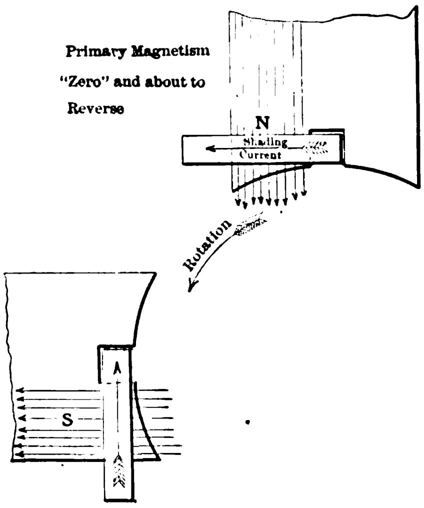

FIG. 6.—ACTION OF SHADING COILS.

Looking back over the process of formation of the magnetic poles, it is seen that north poles have occupied successively the following positions: top "unshaded," top total, top "shaded," side "unshaded," side total, etc. Or, more simply, the north pole, though varying in strength, has travelled in a counter clock-wise direction. This process is continuous, and results in a truly rotating field. A rotor placed in this field is drawn into rotation as though the primary had been properly wound and connected to an unsymmetrical polyphase circuit. This method cannot be satisfactorily and economically applied to motors of large sizes.

A simple method of applying a commutator to induction motors for starting purposes is to utilize current produced in the armature by the alternating flux from the field. In the application of this method the rotor is provided with a winding similar to that of a direct-current armature, connected to a commutator in a manner very similar to that commonly employed with direct-current machinery. Due to facts discussed below, current which flows through the armature, by way of suitably connected brushes, gives to the rotor sufficient torque to bring it under full load to a predetermined speed at which a mechanism operated by centrifugal force causes a short-circuiting device to connect all the segments of the commutator, and thus to convert the armature into virtually a squirrel-cage rotor.

The function of the commutator in the production of the starting torque may be determined by reference to Fig. 7. Consider a closed coil armature supplied with a commutator to be situated at rest between two poles of a motor, which poles are excited with alternating current, as indicated in the drawing. There will be generated in each coil of the armature an alternating e. m. f. of a value depending upon the rate at which that coil is cut by the alternating field flux. The coils which lie in a horizontal plane will be cut by the maximum flux, while those in the vertical plane will be cut by the minimum flux, which minimum will be zero when the plane becomes truly vertical. Though all the coils are connected in a continuous circuit, no current will flow in the armature, since the e. m. f. on one side is equal to that on the other, and the two sides are in series. The maximum e. m. f. will exist between a top and a bottom armature

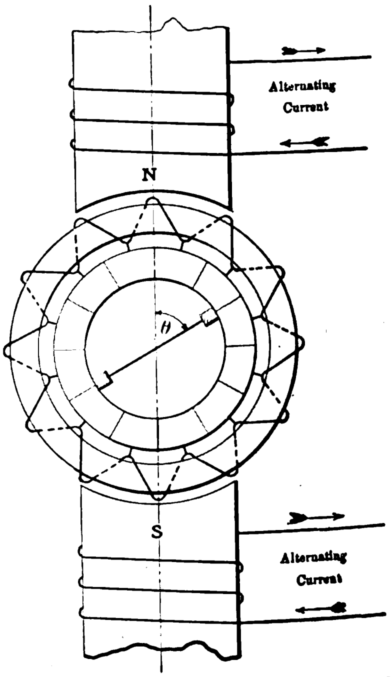

FIG. 7.—PRODUCTION OF STARTING TORQUE.

coil, or between opposite commutator segments, which lie in the vertical plane.

Let E represent the effective value of this maximum e. m. f., then $E \cos. \theta$ will represent the value of the e. m. f. between opposite commutator segments occupying a plane forming an angle of θ degrees with the vertical.

Consider two opposite commutator segments to be connected together externally by a conductor and appropriate brushes, and represent the impedance of the armature and the external circuit by Z. Then a current will flow through this circuit, which current may be represented in value at any given position of the brushes by

$$I = \frac{E \cos. \theta}{Z}.$$

This current will be a maximum when the brushes occupy the vertical plane, and a minimum when they are in the horizontal plane.

Referring again to Fig. 7, and remembering that a conductor carrying a current in a magnetic field experiences a torque which is proportional to the product of the current, the field and the cosine of the angle between them, it will be seen that, for a given current in the armature, the maximum torque will be exerted when the brushes are in the horizontal plane, and that the armature will experience no torque whatever when the brushes are in the vertical plane. In general, the torque may be represented by the equation:

$$T = K \Phi I \sin. \theta$$

where Φ represents the field flux, I and θ being the same as used above, and K is a constant depending for value on units for expressing torque. Substituting for I its value found above, the general torque equation becomes:

$$T = \frac{K \Phi E}{Z} \sin. \theta \cos. \theta = \frac{K \Phi E}{Z} \sin 2\theta$$

which is a maximum when $\sin. 2\theta$ is a maximum, that is, when $2\theta = 90°$ or $\theta = 45°$. This means that the maximum starting torque will be exerted when the brushes are placed 45 electrical degrees away from the centers of the poles.

While the conclusions drawn from the above determined results are correct, and the statement made is strictly in accord with facts, it is quite evident that many elements enter into the determination of the absolute value of the torque which the above equations do not consider.

Obviously, when the current and flux reverse together the torque continues to be exerted in one direction and the rotor is given the desired initial speed previous to being converted to a squirrel cage rotor, as stated above.

Single-phase motors equipped with starting devices of this nature give satisfactory results as to simplicity of operating circuits, efficiency of performance and reliability of service quite comparable to those obtained with polyphase motors, though the large current required for full load torque from standstill and the attendant sparking at the commutator are sources of some objection.

A RÉSUMÉ OF THE ALTERNATING-CURRENT SYSTEM.

BY H. G. REIST.

The first electric generators for commercial lighting were of the alternating-current type, and were used for lighting the Avenue de l'Opera, Paris, in the early seventies, the lamps being Jablochkoff candles. These lamps consisted of two pieces of carbon side by side, with an insulating clay between them. The light was started by placing a small piece of carbon across the upper ends of the two carbon strips, which were disposed vertically. This small piece of carbon was burned and an arc between the ends of the main carbons was thus established.

Shortly after this the self-exciting, direct-current machine was developed, and alternating-current work was lost sight of for a number of years. After the invention of the commercial incandescent lamp the use of electricity for lighting made rapid strides, and the enormous amount of copper required for distribution at 110 volts soon resulted in resort to alternating current.

In the transmission of direct current the drop in voltage in a conductor depends upon the resistance of the conductor, which varies with its length, cross-section and quality of material. In alternating-current circuits, however, the voltage is reduced not only by the resistance of the conductors, but by the self-induction of the circuit, and power may also be lost by hysteresis in iron near the circuit, as in the case of magnet and transformer cores, and by eddy losses in the conductors themselves, or in metal near the conductors. These effects are all proportional to the strength of the current, and since for a given amount of power transmitted the current is inversely proportional to the voltage, the opposing voltage of self-induction decreases with an increase of transmission voltage.

The self-inductive drop is easily controlled so long as high voltages and moderate currents are used, but distribution becomes serious when heavy currents are to be transmitted at low voltages. It becomes practically impossible in an alternating-current system to handle economically such very low voltage currents of thousands of amperes as are generated and distributed by the larger Edison direct-current stations. Even with moderate low-voltage alternating currents, such as are used in secondary distribution, the problem of distribution is more difficult, and far greater skill is required in the construction of the distributing circuits, than is the case with direct current. These difficulties are ordinarily overcome by distributing the low-voltage currents from a great many points, which is accomplished by means of the modern transformer.

GENERATORS.

Great improvements have been made in the construction of alternating-current generators in recent years. These machines, when built in considerable sizes, are made with stationary armatures, the armature core surrounding the field magnet, which revolves. Varnished fabric is used almost exclusively for insulating the windings. Mica is a very good insulator, and is capable of withstanding very high temperatures, such as were frequently developed in earlier dynamos, but mica is a brittle material, and will not withstand the vibration and movement of parts incidental to expansion and contraction due to alternate heating and cooling so well as various organic materials. Moreover, alternators as now constructed show a rise in temperature of only 90 to 105 degrees Fahr., so that it is not necessary to use an insulating material capable of resisting very high temperatures.

The revolving field magnets are usually built up of laminated iron fastened to a spider by bolts in the case of slow-speed machines, and by means of dovetails and keys on machines of higher speeds. The field coils of large machines consist of copper ribbon wound edgewise, so that the coil contains only a single layer of conductor. The convolutions are insulated from each other by sheets of paper cemented to the copper ribbon. This winding is admirably adapted to resist the mechanical strains due to centrifugal force, and also to dissipate the heat generated in the coil, since each turn is exposed to the atmosphere at its outer edge, and the heat is efficiently conducted from the interior to the surface.

Alternators are now designed so liberally that the variation in e.m.f. from no load to full load on a non-inductive load is only from 6 per cent to 8 per cent, without any change in the field rheostat. With an inductive load the regulation of the machine is, of course, impaired, and the variation in e.m.f. may go as high as 18 per cent or 20 per cent. On large machines, where sudden changes in the load are usually only a small percentage of the whole load, no inconvenience results from load fluctuations if the generator has ordinarily good regulation, and no compounding is necessary. On smaller machines, where the starting of an induction motor or the throwing on of a circuit of lamps may add a large proportion of the total load, the change would be so great that the illumination from the lamps in circuit would diminish objectionally before an attendant could adjust the field rheostat; consequently, such machines are usually built self-regulating.

The older method of regulating automatically was to rectify the main current by means of a rectifying commutator, and pass this current through series coils on the field magnet, so that the excitation will increase as the current increases. This system of compounding, however, does not discriminate between the lagging current due to induction motors or arc lamps and that due to an incandescent lighting load. This difficulty has led to the development of the compensating-field machine, which compounds the field excitation more when the load has a low power factor than when the power factor is high.

MOTORS.

There are two types of alternating-current motors in general use; the synchronous machine, which, as its name implies, runs absolutely in synchronism with the system; and an induction motor, the speed of which reduces slightly as the load increases, just as in the case of a shunt-wound direct-current motor. So long as the generator supplying the system runs at a constant speed, the synchronous motor will run at a constant speed, entirely independent of the load it may carry or the fluctuations in the e.m.f. of the line due to line losses or causes other than changes of speed at the generator.

The synchronous motor is simply an alternating-current generator with its functions reversed, and may be built with a revolving armature or a revolving field of the conventional type, or it may be of the inductor type, as in the case of the generator. Like the generator, also, the field windings must be excited by means of direct current. The starting torque of the synchronous motor is comparatively small, full-load current giving a starting torque of only 15 to 35 per cent of the full-load torque. For this reason it is usual to install a friction clutch between the shaft of the motor and a shaft belted, or otherwise connected, to the machine or machines that the motor drives, so that the motor may start free and attain full speed before the load is thrown on. The necessity of an exciter, and the larger current required for starting are the chief objections to the use of synchronous motors. The advantages of the synchronous motor are low first cost, uniformity of speed, and the possibility of eliminating idle currents and obtaining a power factor of unity by over-exciting the motor field.

The advent of the induction motor overcame the most serious objection to the alternating current system by providing a machine equal in many of its characteristics to the shunt-wound direct-current motor. It is even superior to the direct-current machine in the absence of commutator and brushes, and in speed regulation under variable load. The induction motor behaves very similarly to the shunt-wound direct-current motor, having a limited starting torque and showing a slight falling off in speed as the load increases. It differs therein from the series direct-current motor, in which the starting torque is practically unlimited and the speed is inversely proportional to the load. For this reason the induction motor is not suitable for railway work, where frequent stops have to be made.

Three different types of induction motor are offered to meet the requirements of various load conditions. The difference between these is entirely in the armature, the stator or primary being the same in all three types. The simplest form is that in which a squirrel-cage armature is used. This type of motor, as ordinarily constructed, requires from three to five times the full-load current to start with full-load torque. If the machinery to be driven can be started up with less than full-load torque, the current on the line may be reduced proportionately by means of a starting device known as a compensator, which serves to reduce the impressed voltage at the terminals of the machine for starting. A special form of armature is sometimes built for the squirrel-cage type of machine, in which the conductors are of high resistance. This arrangement causes the motor to start with greater torque for a given amount of current, but the speed of the machine varies inversely with the load. It is possible with such a machine to vary the speed with any given load by varying the impressed e.m.f. at the motor terminals.

The second class of induction motor has its armature wound with what is known as a definite winding. All of the windings on the armature are divided into three circuits, one-third of all the conductors being included in each of the three branches. A starting resistance, which is also divided into three branches, is mounted on the armature structure and connected to the three branches of the armature winding. This resistance is gradually short-circuited automatically as the speed of the machine increases, so that at full speed it is entirely cut out. Motors of this class will give full-load torque at starting with approximately full-load current, and a proportionately smaller torque for less current.

Where variable speed is required, it is usually best to provide collector rings on the armature shaft and make the regulating resistance stationary, the connection between the resistance and the armature winding being made by means of brushes on the collector rings. The third class of induction motor referred to is thus arranged. The action of this machines is exactly like the one just described, excepting that a larger amount of resistance material is used, so that if the resistance is in circuit continuously it will not overheat. Motors of this description are generally used for operating hoists and large elevators.

DISTRIBUTION.

For several years after the introduction of alternating-current machinery the single-phase system was the only one used, and for the work which was then being done (lighting alone) this method of distribution is the simplest and probably the best, as only two wires are needed, and there are, therefore, no different circuits which have to be balanced. Small motors may be operated from single-phase circuits with good results. If many machines are to be used, or the motors are larger than about 2 or 3 horse-power, it will usually be found to advantage to use a polyphase system. Moreover, single-phase generators and motors are larger than polyphase machines, entailing greater first cost, and they are also somewhat lower in efficiency.

The two-phase system, which usually consists of four wires forming two separate circuits, requires the same amount of copper for a given distribution that is required by the single-phase system. Some economy in copper may be effected by combining two of the wires, one from each circuit, into one larger wire, making this wire about 1½ times the cross-section of one of the two wires combined. Such a system, however, tends toward unbalancing, which is detrimental to regulation of voltage, and while it is fairly satisfactory where lamps only are used, the four-wire system is a better method of distribution. The three-phase system, as is now well known, is more efficient in copper than any of the other systems. It is necessary to keep the three phases approximately balanced, and in practice there is no difficulty in accomplishing this with sufficient closeness for fair regulation. Sometimes four wires are installed, the fourth wire being a neutral. In this case the lamps are connected between the neutral wire and each of the other three wires.

Where the bulk of the load is single phase, such as lighting and fan motors, with incidental power motors, it is frequently the practice to install three-phase machines and connect all of the lighting load between two of the three wires, the motors being connected, of course, to all three wires. The voltage of the system is then regulated for the single phase in which the lights are connected. With this arrangement the voltage between the two wires supplying the lights is ordinarily lower than that between either one of these wires and the third wire, so that any motor connected to the system will take more of its power from the third wire, thus tending to equalize the potentials and currents in the three wires. This system, on account of its simplicity, has come into quite general use.

Several frequencies are in general use. The lowest frequency regularly employed is 25 cycles. This is used for most alternating-current railway work, and for nearly all large power plants in this country where the current is changed from alternating to direct by means of rotary converters. Current of this frequency is not good for incandescent lighting, although it is sometimes used; the reversals are so slow that if one watches a lamp very carefully a slight flicker can be detected. Arc lamps will not operate at all on 25 cycles.

In a great many power plants a frequency of 40 cycles is used, this frequency having been selected because it is the lowest at which arc lamps can be satisfactorily operated, and at the same time it is entirely suitable for incandescent lighting and motor service, and is very satisfactory for the operation of rotary converters. The frequency most used in this country for lighting circuits is 60 cycles. This is perhaps best adapted for general distribution, all classes of apparatus working very satisfactorily on such circuits. It is, however, more difficult to build rotary converters for this frequency than for 40 cycles or less.

The cost of transformers diminishes somewhat with an increase in frequency. For this reason 125 cycles was the frequency originally used in this country for alternating-current distribution. So long as machines were belt-driven and the current was used for lighting alone, there was not any great objection to this high frequency, but as soon as direct-connected generators came into general use and motors had to be operated, it was found that a lower frequency was very much to be preferred.

It will, perhaps, be well to give a short summary comparing direct-current distribution with alternating current. The distance to which current may be distributed to advantage with the usual direct-current potentials of 110 and 220 volts is very limited, perhaps less than a mile from the station. To reach further points with direct current it is necessary either to put in additional generating stations or to have recourse to alternating current generated at a high potential for transmission and transformed to direct current by rotary converters or motor-generators at sub-stations. The modern method is to have a central station generating alternating current with rotary converter sub-stations wherever needed. If the distribution is accomplished wholly by alternating current no expensive sub-stations with attendance are required, as ordinary transformers may be used, which require no attention, but if the current is to be distributed in large volumes at a low potential, the distribution circuits offer some difficulties, as mentioned above.

Incandescent lighting may be done as well on one system as the other, provided the frequency of the alternating current is sufficiently high to prevent flickering. Arc lighting is now done almost entirely by enclosed arc lamps, which seem to give somewhat more light with direct current, but a better distribution of light with alternating current. On the whole, alternating current arc lamps are somewhat more satisfactory, which conclusion is borne out by the fact that all arc circuits are rapidly being changed over to the alternating-current system. The Nernst lamp seems to operate most satisfactory on alternating current and gives some trouble, I believe, by electrolysis if used with direct current.

Motors are extensively used on both systems. The induction motor, on account of its simplicity and the absence of commutator and brushes, together with its ability to stand abuse, is especially suitable for service where the motors are scattered and likely to receive little or no attention. For constant-speed work, possibly no one will dispute that the induction motor is superior to the direct-current motor from the consumer's standpooint, as the attention and repairs required are ordinarily small items. For variable-speed motors, however, the conditions are reversed, as these may be operated to better advantage on direct-current circuits.

A Comparison of the Steam Piping Systems of the Four Large Electrical Stations of New York.

BY C. G. ROBBINS.

Within the past four years there have been erected or partially erected in New York City four large steam-electrical stations unequalled in the world, either for individual or the aggregate output of their generating units. The list is given above, the first column of figures giving the rated horse-power, and the second the maximum:

	Rated H.P.	Max. H.P.
Metropolitan St. Ry. Co.	44,000	72,000
Third Ave. St. Ry. Co.	70,400	112,000
Manhattan El. Ry. Co.	64,000	100,000
N. Y. Edison Co. (Waterside)	83,200	128,000

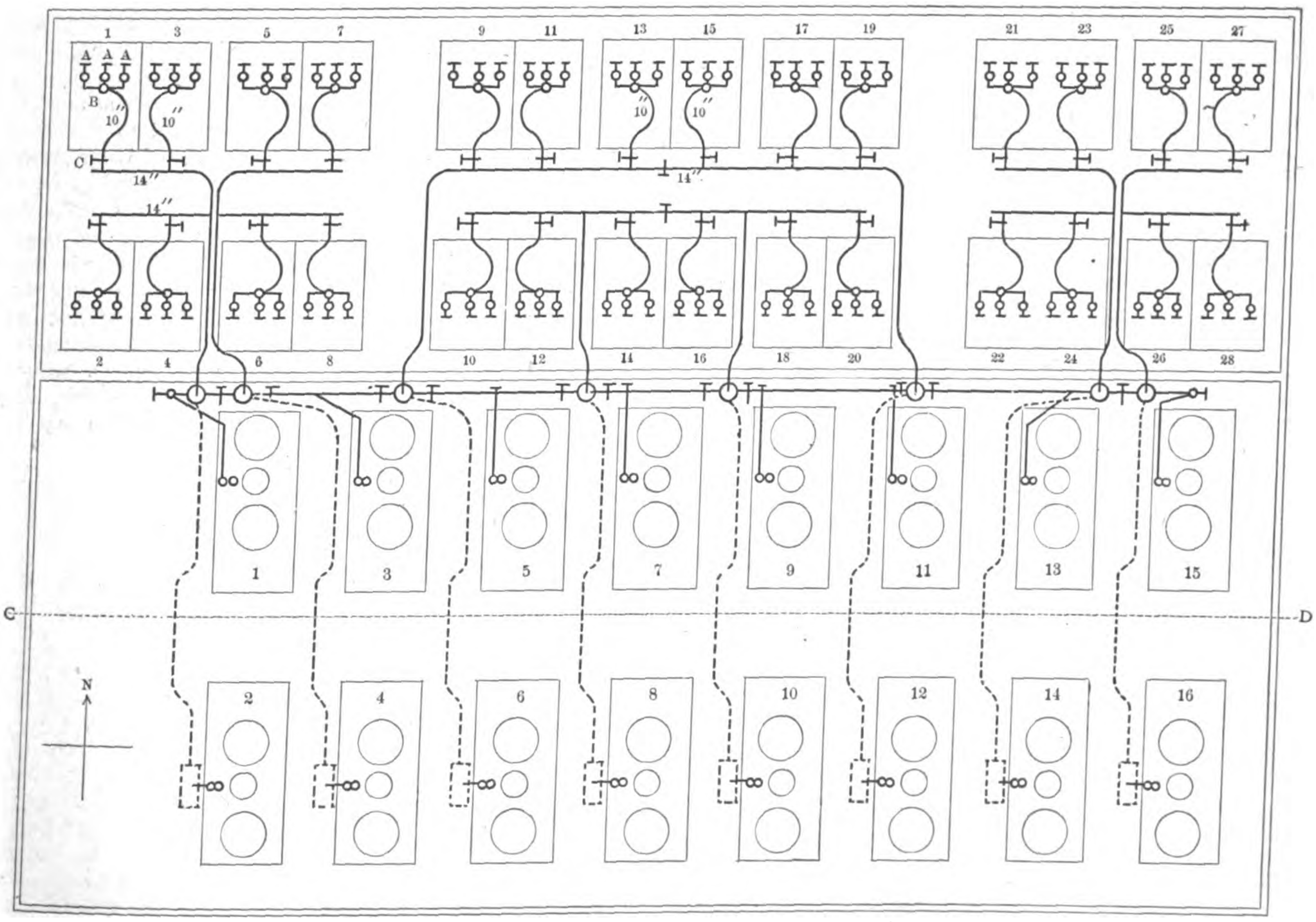

FIG I.—PLAN OF NEW YORK EDISON WATERSIDE STATION.

They have been described by the technical press from time to time and the general arrangement is similar in all four. The boiler and engine rooms are side by side, separated by a fire-wall; the boilers are on two or more floors and are arranged in two rows on each floor; and the engines are of the vertical compound condensing type and arranged in single or double rows parallel to the rows of boilers. This arrangement, while probably more or less necessary on account of the shape of the available ground, undoubtedly affords the simplest and most direct method of connecting the boilers and engines, besides other more important advantages.

The steam systems of these four plants are comparatively simple, but are on a scale never before attempted, and it is the purpose of this article to present them in a manner for easy comparison. To this end the plans and cross-sections have been redrawn to a very small scale, omitting everything but the engines, boilers and connecting pipes, and the outlines of the buildings. Necessarily the drawings are more or less diagrammatic, but the proportions and relative positions have been adhered to as closely as is consistent with clearness, in order that the more important long bends and sweeps may be shown in their true positions. The pipes are shown by single heavy lines; the valves by cross lines or small circles. The pipe sizes are given where known. The over-all dimensions have been given in order that the provision for expansion may be judged and the points of the compass are marked to facilitate reference. The boilers and engines will be mentioned by rated horse-power and not by the maximum.

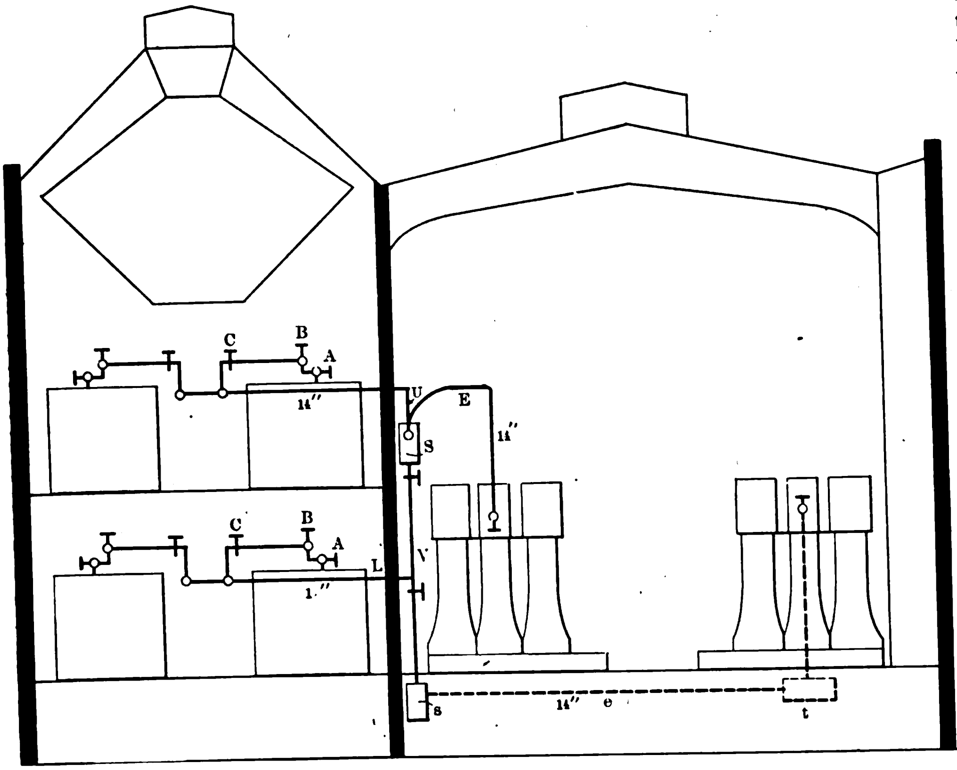

FIG. 2.—CROSS-SECTION OF NEW YORK EDISON WATERSIDE STATION.

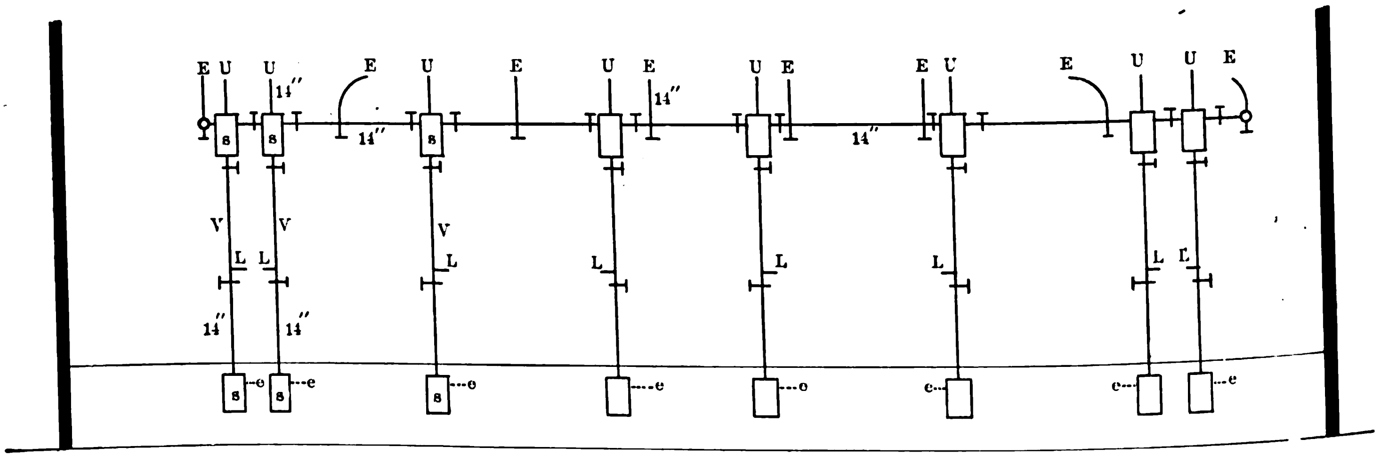

FIG. 3.—LONGITUDINAL SECTION ALONG FIRE WALL, WATERSIDE STATION.

WATERSIDE STATION OF THE NEW YORK EDISON COMPANY.

This is the latest and largest of the four stations. It contains fifty-six 650-h.p. boilers and sixteen 5200-h.p. vertical engines, arranged as in Figs. 1 and 2. The boilers have three steam drums, each drum being connected to a special cross-pipe by a 6-inch angle globe valve *A*, Figs. 1 and 2. On the 10-inch outlet of this cross-pipe is a special automatic steam check angle valve, *B*, from which a 10-inch horizontal bent pipe leads to the 14-inch main in front of the boilers; dropping into the main with a gate valve *C* and an elbow. The arrangement of the mains is shown in Fig. 1 and is practically the same for each floor of boilers.

The mains from the upper floor enter the engine room in eight places and drop into the tops of the special separators *S* on the engine side of the fire-wall just back of the upper tier of boilers at the points *U* on Figs. 2 and 3. This upper row of separators is connected by a horizontal 14-inch pipe, from which the 14-inch leads *E* are taken to the north row of engines. From the bottoms of these separators, 14-inch vertical pipes, *V*, drop into the tops of a set of angle separators, *s*, in the engine room basement; from these separator leads *e* are taken to the south row of engines, as shown by dotted lines in Figs. 1, 2 and 3. The vertical pipes *V* receive the mains from the lower tier of boilers at the points marked *L* on Figs. 2 and 3. This makes practically a two-story plant, the upper tier of boilers for the north row of engines and the lower boilers for the south row. Provision for using either tier of boilers to supply either row of engines is furnished by the 14-inch horizontal main connecting the upper separators *S* and the vertical pipes *V*. The leads *E* for the north row of engines rise from the main with a long bend, extend horizontally to points over the engines and drop directly into the tops of the throttle valves, as shown by solid lines in Figs. 2 and 4. Those for the south engines run horizontally in the engine-room basement to a third set of angle separators, *t*, directly under the throttles; from the *e* separators 14-inch vertical pipes lead to the lower flanges of the throttles, as shown by the dotted lines in Figs. 2 and 4. In each case the overhanging throttle is supported from below.

Each engine is rated at 5200 horse-power and uses 12½ pounds of steam per horse-power hour, or 65,000 pounds at rated load. Each boiler is guaranteed to economically evaporate 22,000 pounds of water per hour, so that three boilers are required for each engine. Inspection of Figs. 1 and 2 shows that the arrangement of cut-out valves is such that the entire station may be divided into sixteen practically separate plants: Boilers 1 to 4, inclusive, supplying engine No. 1; boilers 5 to 8, engine No. 3; 9, 11 and 13, engine No. 5; 10, 12 and 14, engine No. 7; 16, 18 and 20, engine No. 9; etc. Duplicate boilers on the lower floor supply the south row of engines, provision for separating the floors being made by putting gate valves in the vertical pipes *V*, just under separators *S*.

A noticeable feature of this piping system is the use of apparatus which combines its own function with that of a fitting, (ell, tee, cross, etc.). The turn at the boiler from vertical to horizontal is made by the angle check valve *B*; the separators *S* answer the purpose of a cross, connecting the inlet, the vertical pipe V and the horizontal main; separators *s* and *t* and the engine throttles are of the angle type; and the cut-out valves for the north row of engines are combined each with the tee in the main in the form of a cross-valve, except for the end engines, where the turn is made with an angle valve.

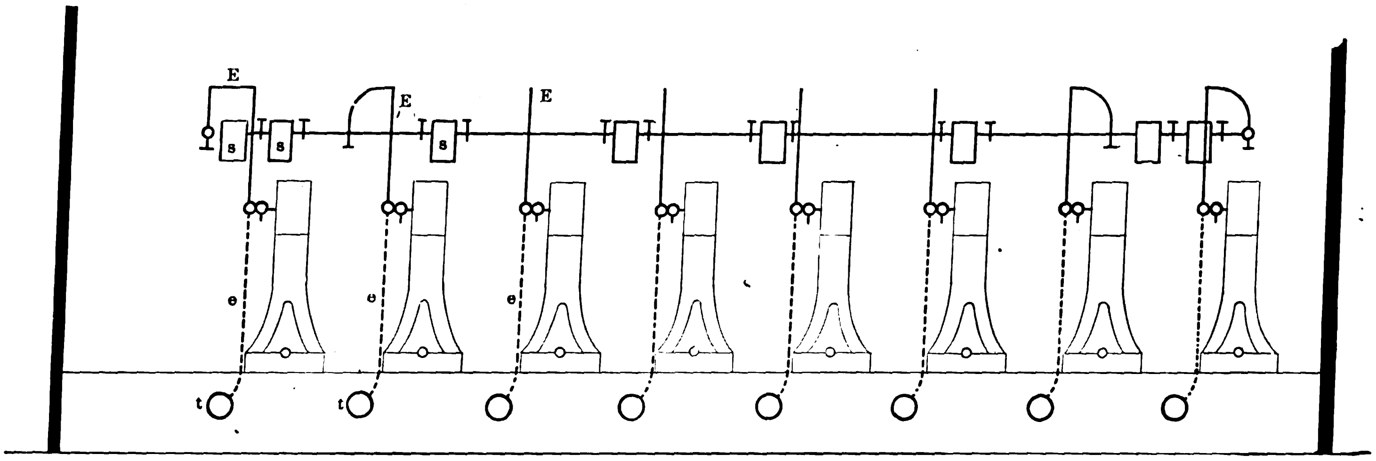

FIG. 4.—LONGITUDINAL SECTION ON LINE C D, WATERSIDE STATION.

This is the first instance in the writer's observation where this practice is carried to such an extent. It would ordinarily be objectionable on the ground that the apparatus, separator or valve, would not be accessible for examination or repair without interfering with its other function. In this case the cut-out valves are so placed that the above objection is not applicable.

Another noticeable feature is that all of the high-pressure steam piping, with the single exception of the boiler branches, is the same size as the engine throttle, namely, 14 inches. The piston speed is 750 feet, giving a steam velocity of 8000 feet per minute in the engine supply pipes.

The piping is of wrought iron with screwed flanges, and the joints are ground or scraped to a fit and made up without gaskets. The automatic valves *B* are of special design, arranged to close upon a reduction of pressure in either boiler or main. The gate, angle and cross-valves are also special and of the outside-screw type with steel spindles. Gearing is provided, in most cases for convenience in operating. Wherever it is impossible to balance the pressure before opening, the valves have by-passes.

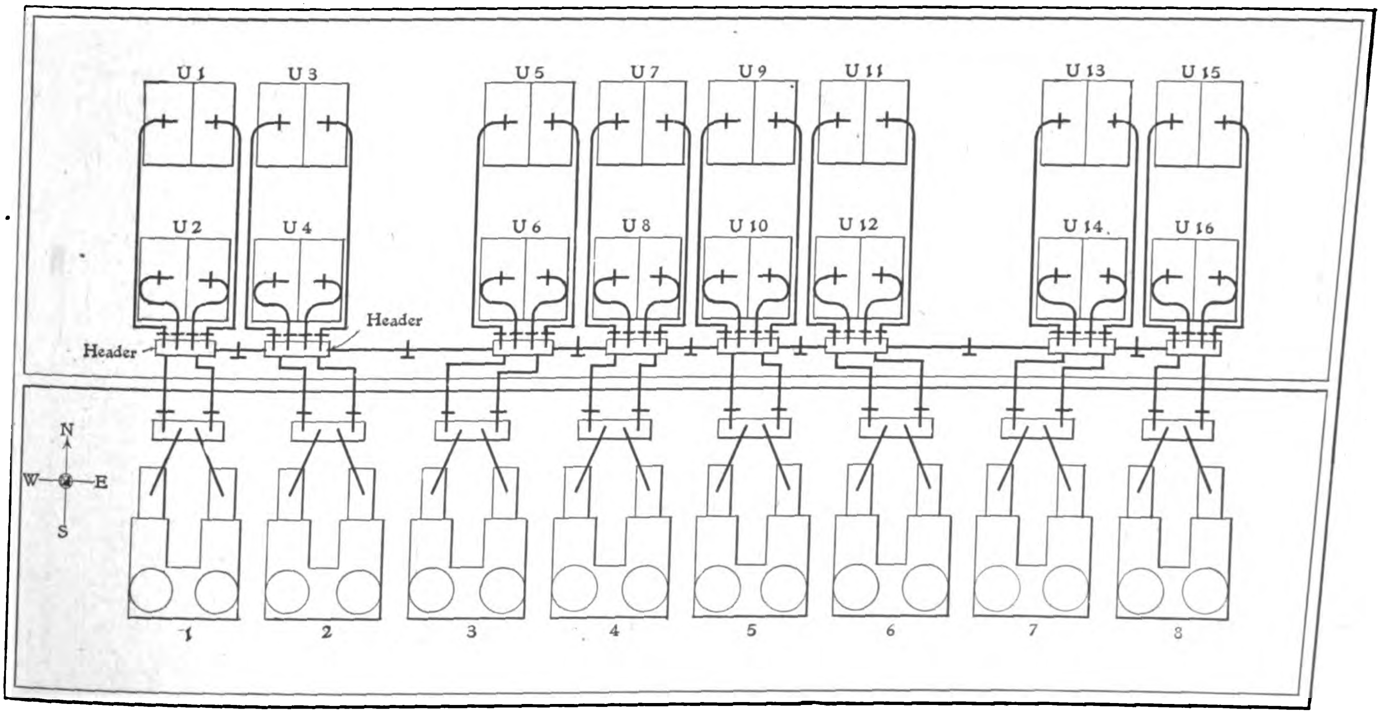

FIG. 5.—PLAN, MANHATTAN ELEVATED RAILWAY POWER STATION.

Concerning the provision for expansion it will be seen that the leads *e* to the south engines and the horizontal main connecting the upper separators *S* are the only parts where the provision is not evident at first sight. Of these, the pipes *e* are bent out of a straight line connecting the separators, and have besides a long vertical pipe at the end, affording ample springiness.

The horizontal main has comparatively short connections at the center, where the expansion is small, but longer and more flexible connections for both engines and boilers at the ends where the expansion is greatest. The boiler piping also permits considerable movement without straining the joints, and connections to the drums are made with special spherical ground joints. The writer understands that possibly the leads *e* for the south engines will be connected by a tie-main extending through the engine room basement along the line *CD*, Fig. 1.

The plant is designed for a pressure of 225 pounds per square inch, with a high degree of superheat; the engines are rated on the basis of a pressure at the throttle of 175 pounds

MANHATTAN ELEVATED R. R. STATION.

This station was erected to supply current for the elevated railways of New York City, the change of motive power from steam to electricity being now almost completed. It consists of sixty-four 500-h.p. boilers and eight 8000-h.p. engines, arranged as shown by Figs. 5 and 6.

The boilers are on two floors and are arranged in two rows on each floor, the plans of the two floors being identical. The engines are practically double engines, each one having two horizontal high-pressure cylinders, and two vertical low-pressure cylinders, as indicated in Fig. 6. The plant is practically divided into eight sections, each consisting of one engine and eight boilers. On a basis of 13 pounds of steam per h.p.-hour for the engines and 30 pounds for the boilers, just seven boilers are required for each engine, leaving a spare boiler in each section. For convenience of reference, the batteries on each floor are lettered and numbered, the upper batteries being designated, *U1*, *U2*, etc., and the lower ones, *L1*, *L2*, etc. Referring to Figs. 5 and 6, it will be seen that batteries *U1*, *U2*, *L1*, and *L2* supply engine No. 1, and so on.

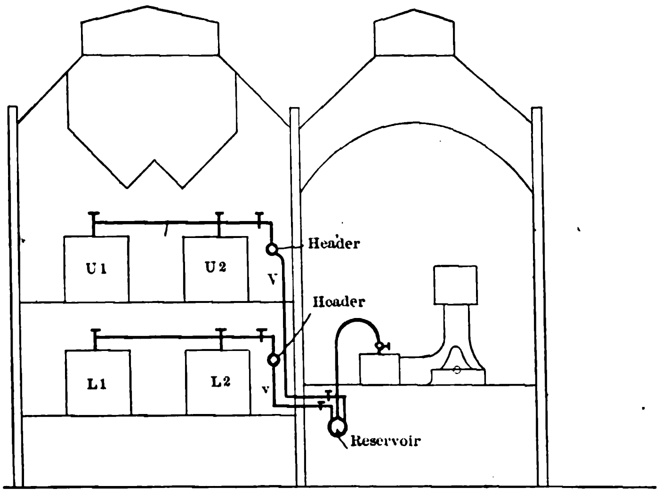

FIG. 6.—CROSS-SECTION, MANHATTAN ELEVATED RAILWAY POWER STATION.

Directly behind each battery of boilers in the south row on each floor is placed a short 18-inch header, or drum. A short vertical pipe rises from the steam nozzle of each boiler and from these, horizontally bent pipes of the forms shown in Fig. 5 are run to this 18-inch header, dropping into the top with an elbow and short pipe; each header receives the pipes from the four boilers of two opposite batteries. In the engine room basement and directly behind each engine is a steam reservoir 36 inches in diameter and upwards of 20 feet long. Steam is supplied to each one of these reservoirs by the two pipes, *V* and *v*, Fig. 6, leading from the upper and lower 18-inch headers, respectively. From this reservoir steam is taken to the two high-pressure cylinders of the engine by two vertical pipes rising through the floor and dropping into the tops of the throttles with a semi-circular bend, shown in Fig. 6. The exciter engines also take their steam from this reservoir in a similar manner. Two gate valves are used in each boiler branch, one close to the boiler and the other near the header; gate valves are also placed in the vertical pipes *V* and *v* near the reservoir. Each of the eight units is piped in the same manner and the headers on each floor are connected by the longitudinal main shown as a single line on Fig. 5. This equalizes the pressure and allows any deficiency in one unit to be made up from the others. Gate valves in this main allow any unit to be entirely cut out from the rest of the plant.

Ample provision is made for expansion. The headers are too short to expand appreciably in a longitudinal direction, and being connected only to comparatively long vertical pipes, they are free to move transversely with the expansion of the boiler branches. These branches in turn have long horizontal bends and those from the north row of boilers have an additional horizontal bend near the header, allowing considerable movement. The leads from the reservoir to the throttles are very flexible, as are pipes *V* and *v*, on account of the two right-angled bends.

The mains connecting the headers rise from each header with a long bend, the horizontal portion thus being considerably higher than the headers and so providing for longitudinal expansion.

The whole system is exceedingly simple and apparently efficient. It does not appear from the plans at the writer's disposal that any effort has been made to use combination fittings answering two purposes and saving joints, as was done in the New York Edison station, just described. In this case the

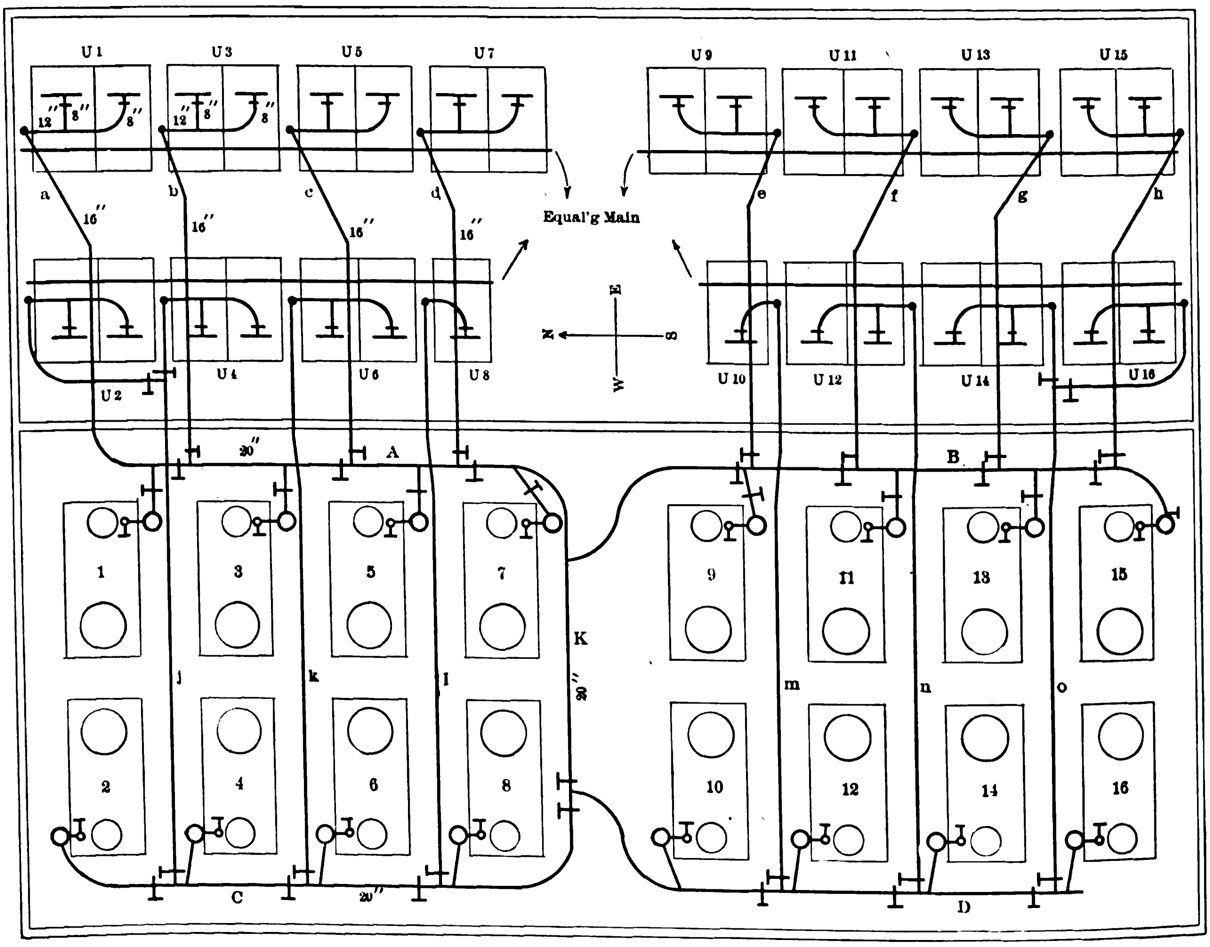

FIG. 7.—PLAN OF THIRD AVENUE RAILWAY COMPANY'S POWER STATION.

general arrangement does not lend itself so readily to that practice. The piping is of wrought iron, with welded flanges and ground joints; and outside screw gate valves are used, with by-passes where necessary to equalize the pressure before opening.

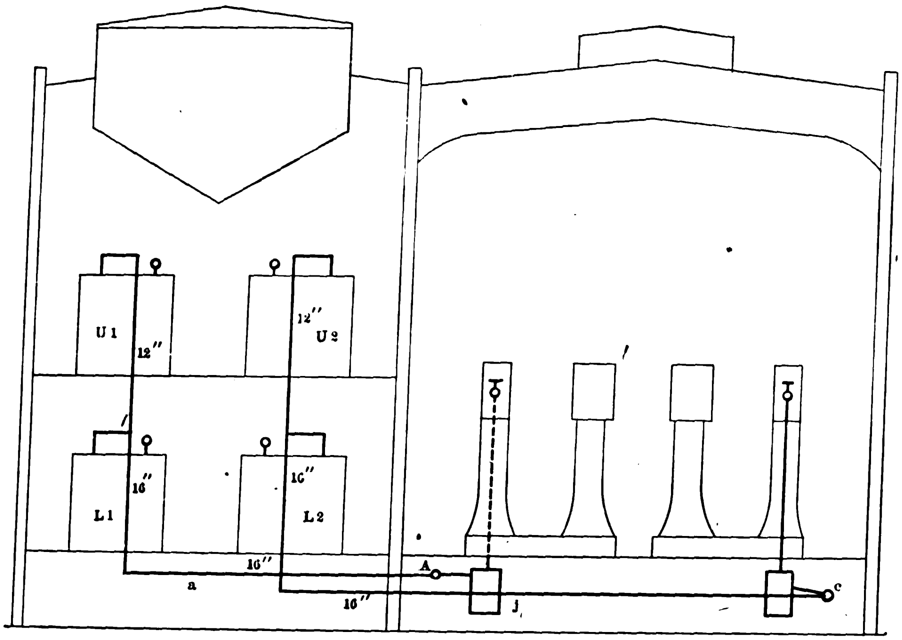

FIG. 8.—CROSS-SECTION, THIRD AVENUE RAILWAY COMPANY'S POWER STATION.

The plant is designed to carry a working pressure of 200 pounds per square inch, although a lower pressure is ordinarily carried at the engines.

STATION OF THIRD AVENUE RAILWAY CO.

This was the second of the four mammoth stations and contains sixty 520-h.p. boilers and sixteen 4400-h.p. vertical engines. The arrangement is shown in Figs. 7 and 8, the boilers being in two duplicate tiers or floors. In this case the plant is primarily divided into four sections, the east rows of boilers supplying the eastern engines and the western boilers the western engines; the north and south ends of the station are practically separated by the space at the center for the central condensing apparatus. In the New York Edison station, the upper boilers supply one set of engines, while the lower boilers supply the other row of engines. In this station, as in the Manhattan Elevated, the upper and lower boilers of the same rows are connected to supply one row of engines.

The two 8-inch boiler branches of a battery are consolidated into a 12-inch branch, as shown at battery U^1, Fig. 7. On the upper floor this 12-inch branch runs horizontally to a point over the passage between the batteries and drops vertically to a similar point on the lower floor, where it is joined by the 12-inch branch of the lower battery, the two delivering to a 16-inch main, as shown in Figs. 8 and 9. These 16-inch mains, marked *a*, *b*, *c*, etc., drop through the

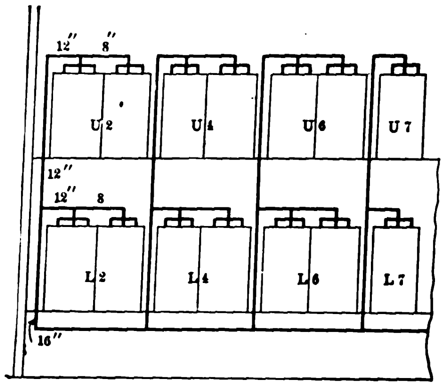

FIG. 9.—LONGITUDINAL SECTION OF BOILER ROOMS.

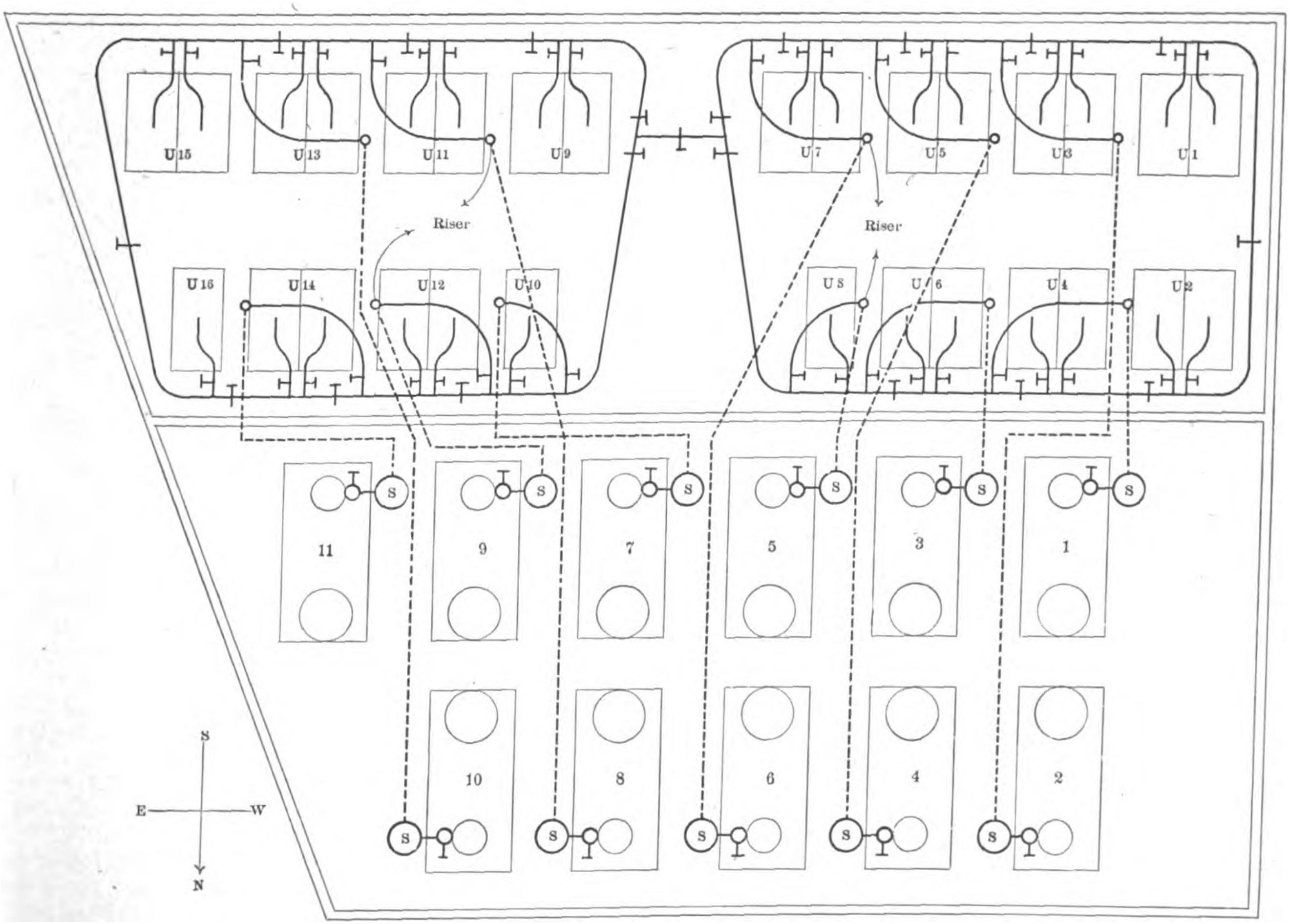

FIG. 10.—PLAN OF METROPOLITAN STREET RAILWAY COMPANY'S POWER STATION.

floor and extend into the engine room basement, connecting there to 20-inch equalizing mains, from which leads are taken to the engines. These equalizing mains, *A, B, C, D,* are four in number, cross-connected near the center, as shown by Fig. 7; the eastern ones, *A* and *B,* receive the 16-inch mains, *a* to *h,* from the eastern boilers, and the western ones, *C* and *D,* receive mains *j* to *o,* as in Figs. 7 and 8. The engine leads are taken from these mains to angle separators, from the tops of which vertical pipes lead to the lower flanges of the 14-inch throttles.

Cut-out valves are so located in the equalizing mains that the station can be divided not only into four groups, as mentioned above, but also into practically sixteen units, each consisting of one engine and four boilers; except in the cases of engines Nos. 8 and 10, which would then be supplied by only two boilers each, boilers *U8* and *L8* for engine No. 8 and *U10* and *L10* for engine No. 10. But the boiler power is ample and the equalizing mains allow these engines to be fully supplied with steam when running alone or in combination with others.

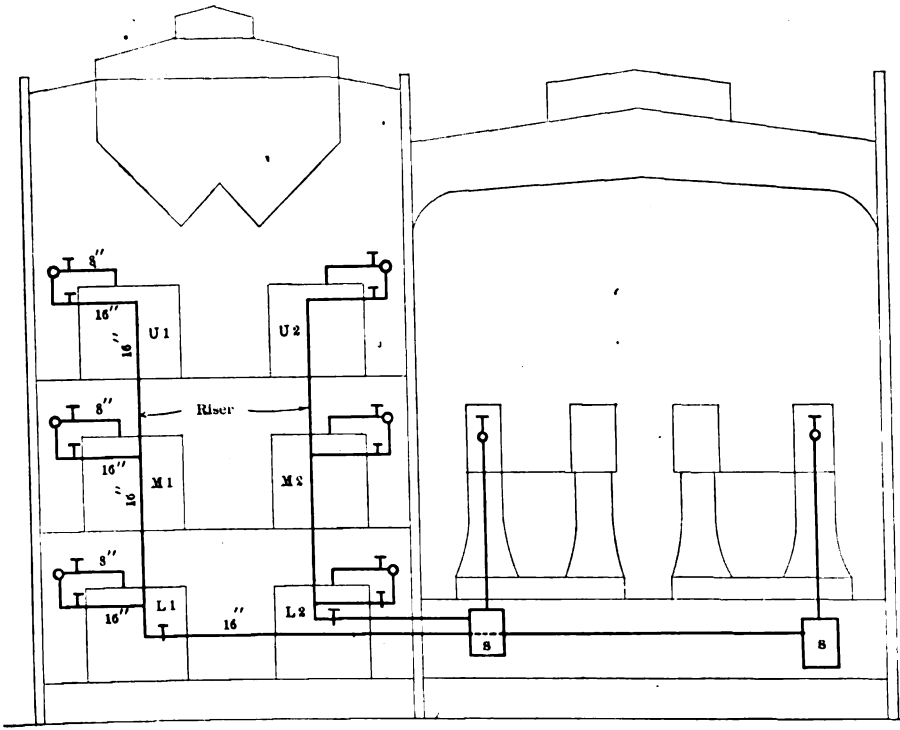

FIG. 11.—CROSS-SECTION, METROPOLITAN STREET RAILWAY COMPANY'S POWER STATION.

The cross-connections of the equalizing mains allow almost any combination of boilers and engines; for example, engine No. 16 may be fed from boiler batteries *U1* and *L1* through the 16-inch main *a,* equalizing main *A,* cross-pipe *K* and equalizing main *D,* with all other boilers and engines cut out. Each of the four groups of boilers is provided with an equalizing main connected to each boiler independently of the main outlet pipe. The object of this is to equalize the pressure in the group and so prevent fluctuations due to variable demand or unequal firing; the steam for auxiliary apparatus is also taken from these mains. The piping shown is of special wrought iron; the fittings are extra heavy cast iron, and extra heavy iron-body outside-screw gate valves are used.

Expansion is well provided for. The equalizing mains *A, B, C* and *D* are practically free at one end and the long horizontal mains connecting to them are free to swing about a vertical axis. The 16-inch mains are quite long, especially those marked *j, k. l, m, n,* and *o*; but these mains with the boiler mains at one end and the engine leads at the other, form U-shaped sections in which the horizontal pipe is free to expand without straining the joints. The equalizing mains over the boilers appear more likely to make trouble. The plant is designed for a working pressure of 200 pounds per square inch.

METROPOLITAN STREET RY. STATION.

This station supplies current for the surface railways of New York City and is made up of eleven 4000 horse-power engines and eighty-seven 250 horse-power boilers. The engines are in two rows and the boilers are in three tiers or floors, and arranged in two rows, as shown by Figs. 10 and 11. Owing to the arrangement of the boilers in three tiers and the unequal number of boilers and engines in the two rows, a rather peculiar arrangement of piping has been used.

The large brick stack in the center of the building practically divides the boiler plant into two sections on each floor. A 16-inch ring main encircles each group of boilers on each floor and receives the 8-inch branches from the boilers. At intervals 16-inch leads are taken from this ring main to supply the 16-inch vertical risers located in the passageways between the batteries of boilers. These risers or standpipes are eleven in number, one for each engine, and extend the full height of the three floors, receiving at each floor the 16-inch lead from the ring main. In the first story they turn and run horizontally into the engine basement, where they connect to angle separators *S* placed directly under the engine throttles. From these separators 14-inch leads are taken up through the floor to the engine throttles, as shown by Fig. 11.

The ring mains are cross-connected on each floor, as shown in Fig. 10, to allow interchangeability of boilers and engines. A gate valve is placed in each boiler branch near the main, in each lead from the main to a riser, and in each horizontal run from a riser to a separator. Gate valves cut the ring main up into sections, so that the risers may be fed from either direction. This arrangement is particularly flexible as regards cross-feeding. All of the seven or eight boilers required to supply any one engine may be on either of the floors or may be distributed among the three floors; and extreme opposite boilers and engines may be run together.

No attempt was made to assign any particular boilers to each engine, the cut-out valves in the main being so located that the boilers nearest a given riser may be used while all others are out of commission.

The piping is special wrought iron and the flanges are of extra heavy cast steel, riveted to the pipe in some cases, and connected to it by the Van Stone method in others. Extra heavy cast-steel fittings are used.

As previously mentioned, the arrangement of the four plants is substantially identical, and at first sight there appears no evident reason save the individual preferences of the designers why the same scheme of piping would not have served for all. The New York Edison system is thoroughly efficient and is probably the simplest of all, though apparently complicated somewhat by the arrangement of the boiler connections for superheating. It possesses two features of superiority over the others: First, the use of only two sizes of pipes, and second, the elimination of unnecessary joints by the use of combination fittings.

This scheme could have been applied directly to the Third Avenue Railway plant with some saving in the omission of the 20-inch loop piping in the engine room and a reduction in size of the leads from the boiler room. The radiation loss would certainly have been much smaller. It would be interesting to know also if the equalizing mains connecting the boilers of this plant have been found necessary in practice.

The same scheme would also have been applicable to the Manhattan plant by placing the main at a lower level. But if this were done the main would necessarily be large enough to supply the two throttle pipes of one engine, in order that the extreme opposite boilers and engines might be used together. However, there is very little, indeed, to criticise in the Manhattan plant, unless it is the use of the short 18-inch headers behind the boilers. These might have been made throttle size and the connecting mains of the same size, still allowing perfect interchangeability of engines and boilers; and in that case only two sizes of pipe would have been required.

A very commendable feature of this plant is the use of exceedingly large reservoirs close to the engines. Each reservoir has a capacity about three and one-quarter times that of the high-pressure cylinder of its engine and will furnish a practically continuous flow of steam to the steam-chest, avoiding the fluctuations of pressure with the strokes of the engine, which it seems will obtain in a greater or less measure in the other plants.

The Edison arrangement would hardly be applicable to the Metropolitan plant, since in this case there are three tiers of boilers and but two rows of engines. Shorter runs might have been obtained in this plant by placing the south mains over the firing-space, as in Fig. 1, but in that case the risers would have obstructed the firing floor.

Considering the magnitude of the installations, two very noticeable features are common to the four plants. The first of these is the absence of high-pressure expansion joints, which are almost always a source of annoyance. The second is the extreme simplicity of the required high-pressure drip systems; in all cases the flow of steam is downward from the boilers and upward to the engines, with reservoirs or separators at the low point to catch the condensation. With the possible exception of the long loop mains in the Third Avenue and Metropolitan plants, it seems that a drip system connecting the separators would fulfill all requirements. This vastly simplifies the systems.

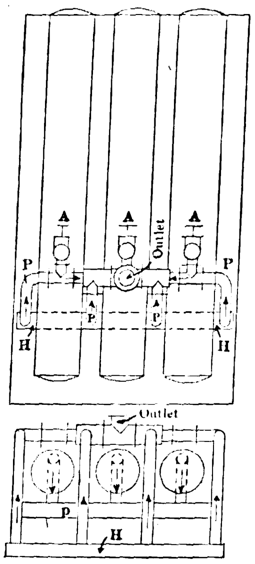

FIG. 12.—SUPERHEATER CONNECTION.

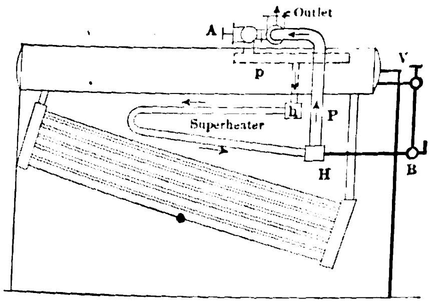

FIG. 13.—SUPERHEATER CONNECTION.

In ordinary plants the steam main or header is usually of sufficient size to allow either half of the boiler plant to supply the maximum steam demand of the extreme opposite half of the engine installation. In these stations, each generating unit requires from four to eight boilers, which are connected to supply that engine. These groups are then connected only to enable any single group of boilers to supply any individual engine, except in the Third Avenue plant, where each side of the 20-inch loop main will supply two engines, allowing extreme opposite quarters of the plant to be run together. The extreme improbability of a break-down of enough units to render such cross-feeding necessary has led to the use of smaller and correspondingly cheaper piping.

Again, no attempt has been made toward the duplication of piping which was carried to extremes some few years ago. By this is meant the use of two mains with a double outlet and two branches for each boiler, which was formerly not uncommon. The use of high-class materials and the proper placing of cut-out valves, together with the extreme of care in erection, has resulted in fewer leaks and shut-downs than the most elaborate duplication.

A feature of general interest is the superheater connection adopted by the New York Edison Company, and shown by Figs. 12 and 13. It is designed to allow the superheater to be used as additional boiler heating surface or as a superheater, as may be desired. Inside each drum is a dry-pipe, *P*, connected to the built-up cross-pipe by the angle globe valve *A*. Each dry-pipe is further connected through the bottom of the drum to the upper header *h* of the superheater, and the lower heater *H* is connected to the cross-pipe by the four pipes *P*. When the superheater is in use, the valves *A* are closed and the steam goes downward from the dry-pipe through the superheater and thence upward through pipes *P* to the cross-pipe and outlet, as shown by the arrows. The superheater may be flooded and thus converted into ordinary heating surface by opening valve *V;* the valves *A* are then opened and the steam goes directly from the dry-pipe to the cross-pipe and outlet. The three-way valve *B* is used for blowing out the superheater. This description of the superheater, which is of ordinary type, is given to show the necessity for the three extra valves *A,* which would not be required on boilers generating either saturated or superheated steam exclusively.

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Calorific Values of American Coal, Oil and Fuel Gas.—According to an English contemporary, tests of American coal show a calorific value of 14,450 B. T. U. for anthracite and 14,470 for bituminous coal per pound. Heavy Pennsylvania petroleum gives on the average 20,000 B. T. U. per pound; light oil 18,000, and Ohio and West Virginia oils give 18,500 per pound. Results of 192 boiler tests show an average evaporative duty for all kinds of coal of 10.8 lbs. of water per pound of coal for water-tube boilers and 10.4 for tubular boilers, the evaporation being taken from and at 212 degs. Fahr. C. D. Gray gives the following figures as the calorific value of different gases expressed in B. T. U. per cubic foot: Natural gas, 1033; coal gas, 706; carburetted water gas, 651; uncarburetted water gas, 319; producer gas, 143; and blast furnace gas, 102.

The figures for coal that are commonly accepted in this country do not run so high as those quoted above, and the average evaporation is nearer 9 lbs. of water per pound of coal than 10.4 or 10.8.

PRACTICAL POLYPHASE WORKING.

BY DR. LOUIS BELL.

This paper is not for the benefit of the man who knows all about polyphase machinery in theory or thinks he knows all about it in practice, but rather for the information of the chap who knows a little about direct-current and alternating-current dynamos and wants to know something of the practical nature of modern polyphase apparatus. I am going to waste no time in a detailed description of dynamos, but rather deal with the installation and operation of polyphase stations for the benefit of him who has to build and run them, with special reference to the power transmission work for which such apparatus is most extensively used.

Polyphase generators are not widely different from other alternating generators in their general characteristics; that the armatures are fitted to deliver current in two or three phases instead of simple alternating current is a matter of much importance for certain purposes but bearing no relation to the actual character of the machine. Polyphase generators, therefore, look and operate very much like other alternators, are similarly excited and similarly handled in most particulars. The practical differences, due to the polyphase construction, from an operative standpoint are:—

First, that the connections—particularly the switchboard connections—are necessarily more complicated in the polyphase than in single-phase work. The machines themselves are somewhat more complicated in the matter of windings, compensating for this failing, however, by giving a somewhat better output for a machine of given size. Finally, polyphase machines as a rule are better in point of inherent regulation than single-phase machines, and consequently require, on the whole, less attention to the excitation.

Very many modern alternators are so arranged that the armature coils are stationary while the fields revolve, and this is the construction generally employed in polyphase machines used for power transmission, save when the voltage is comparatively low. In all cases where the voltage is more than 1000 or so at the generator, the revolving field construction is preferable, because the armature coils—which must be insulated against the high voltage—are not subject to centrifugal strains, but are firmly wedged into the stationary part of the machine. One, therefore, generally finds on going into a polyphase transmission station that he is dealing with rotary field machines, having fixed armature coils and wires leading out from them in the simplest possible manner and going to the switchboard.

These generators will be either two-phase or three-phase, and from the standpoint of the man who is to operate them there is very little choice. The two-phaser has four leads; while the three-phaser has three leads, but the somewhat simpler circuits of the latter are offset in a considerable measure by the fact that the wires of a two-phaser form two well-defined circuits, not interlinked as in three-phase machines but entirely independent of each other. The generators will either be high-voltage machines feeding directly into the line, or machines of more moderate voltage feeding a bank of raising transformers. The former arrangement is rather the simpler, and where the line voltage is not to exceed 10,000 or 12,000 volts this arrangement is probably preferable. For higher voltages the raising transformers are regularly used. One hears much about the relative advantages of the two arrangements, but the practice of the last few years with high-voltage machines seems to have definitely settled the fact that they have a well-defined sphere of action in which they are extremely useful. When built with stationary armature coils, it is not a difficult matter to insulate them originally or to keep them insulated afterwards.

It often used to be said that in case of a burn-out, such as might occur if the system were struck by lightning, the high-voltage machine would lose its armature, while the low-voltage machine would be uninjured, whatever damage might occur being at the transformers. Now, in point of fact, the modern transformer for power transmission purposes is a much less comfortable thing to repair in case of damage than a high-voltage generator. If a coil of the former burns out it generally makes such a mess of the interior of the transformer, particularly in the case of oil insulation—almost invariably used for very high-voltage work—that the whole affair has to be overhauled. If a coil in a machine is damaged it is not a difficult matter to cut it out and replace it by a fresh one. (Such coils should always be kept in stock.)

In case of need a damaged coil can simply be cut loose from its fellows in that particular circuit and a short bit of wire connected in place of it, so that the coil is simply dropped out of the generator. The generator thus temporarily repaired can be forced up practically to its full voltage without trouble, and will even run in parallel with its uninjured mates. In case of damage to a transformer the whole transformer has to be cut out of action—usually, I am sorry to say, not a very simple performance—and replaced by another, or in the case of three-phase circuits possibly removed and the remaining transformers reconnected. Looked at from any standpoint, transformer repair is practically as serious as the repair of a burnt-out coil in the generator itself.

In the case of transmission circuits the line is invariably worked three-phase. If the generators are two-phase this arrangement of the circuit is transmitted into a three-phase circuit by means of Mr. Scott's very beautiful arrangement of phasing transformers, which is now well known and of which a description may be found in almost any book treating on three-phase work.

From an operative standpoint there is little difference between the two arrangements of generators. The three-phase machines are a little more susceptible to changes of voltage in case the load is badly unbalanced. The two-phase machine is subject to a slight disadvantage in the phasing transformers.

It must be understood that in this arrangement of transformers a part of the energy is delivered by voltages which are resultant voltages; i.e., are derived from two sets of transformer coils working in quadrature instead of directly from a single coil. In phasing transformers, you may imagine the voltage is delivered from the free ends of two coils forming the two rectangular sides of a right-angled triangle instead of from a single coil occupying the place of the hypothenuse. This means that the energy is derived from this arrangement of transformers at a slight disadvantage. The same is true of any other arrangement of transformers in which the voltage derived is a resultant voltage.

For example, when a three-phase current is derived from two transformers instead of three, a part of the energy is due to a resultant voltage, and consequently the transformers work at a slight disadvantage, which generally shows up in a somewhat greater rise of temperature than would be the case if three transformers of the same calibrated capacity were being used. This matter, however, of the manner in which the three-phase current for the line is derived, is settled once for all when the station is built and one with which the operation of the station is not directly concerned.

In organizing or operating a polyphase generating station the added complication of polyphase circuits appears mainly in the switchboard and its connections, and to this close attention ought to be paid. A switchboard for a transmission plant should above all things be accessible and so arranged that all the high-voltage wires can be quickly seen and inspected. More stations get into trouble from crowded switchboards than from any other one cause. One usually finds the switchboard apparatus of a transmission plant disposed in symmetrical panels, one for each generator, and very conveniently and compactly arranged. In putting up such panels, however, there are certain things which the practical constructor and operator should look out for. See to it that the panels are not placed too near the wall of the station; that there is ample space to work behind them without getting dangerously near to any high-voltage wires, and that the space behind the board is particularly clean and well lighted. Nothing is more troublesome or dangerous than trying to execute quick repairs or changes of wiring behind a high-voltage board in use when there is insufficient space or bad light. As a rule the switches are operated from the front of the board, where there is no particular danger of fireworks, and this is almost invariably well lighted, but the back of the board, where the trouble is likely to be, is too often in a dark corner.

The usual weakness in panel switchboard is insufficiency of instruments. Tastes differ in building switchboards and the standard panels are generally arranged with a minimum of instruments rather than all which might be considered necessary by some engineers. In any polyphase station there should particularly be means for ascertaining the voltage belonging respectively to each phase. One ammeter and one voltmeter are not enough to ascertain the condition of affairs on a three-phase circuit. Potential transformers for high voltages being somewhat costly, there is usually a tendency to employ as few as possible and it is rather rare to find a station so arranged that the operator can see at once what is going on on his circuits. Personally I am a great believer in station wattmeters, but they are expensive and sometimes there is a natural hesitation in putting them in at first, but at all events there should be an opportunity for getting the voltage of each phase and the potential transformers installed for this purpose ought always to be large enough to permit the connection of wattmeters later if the occasion requires.

Where raising transformers are used it is increasingly common, and on the whole rather good practice, to control the circuits as far as possible from the low-voltage side and let the transformers alone except in case of need. It is advantageous, however, to have the transformer connections so made that a transformer can be cut out and replaced by another without any long delay. The fuses, switches, etc., are regularly on the low-voltage side of the transformers, except in rare instances.

One weak point of a good many installations which I have inspected is in the matter of fuses. It should be borne in mind that troubles which cause short-circuits are more frequently in and about switchboards than anywhere else, and, therefore, that it is pretty good policy to have, if not the principal set, at least a set of fuses or cut-outs between the generators and the board, so that if anything happens the machines will cut themselves free.

Most polyphase plants are operated with very sensitive and powerful governors on the prime movers, whether engines or water-wheels, so that if a heavy load comes on, the machine will maintain its speed and its voltage as far as possible; consequently a bad short-circuit on the board will throw everything wide open at considerable risk of doing damage. Sometimes very valuable machines have been ruined by short-circuits occurring inside the building when cut-outs placed near the machine would have saved many thousand dollars' worth of damage. All this, of course, pertains to machines in general as well as polyphase machines, but the latter from rather more complicated wiring are perhaps a trifle more likely to catch it in this way than are direct-current or simple alternating generators.

A word here about operating polyphase generators in parallel. When run from water-wheels or properly governed engines, such machines go into parallel and stay there with as great facility as any type of generators which can be found. Certain things, however, have to be borne in mind in throwing them in parallel. The speed of the machines must, of course, be the same. The voltages must be as nearly equal as may be and the machines must correspond accurately phase for phase. In the early days of polyphase working I remember a curious incident which serves to impress the last named necessity. I had been arranging an installation of a pair of small three-phase generators to be operated in parallel. The first one had been started up and was working regularly when the second one was installed, and after giving careful instructions to the man in charge and seeing that the phasing connections were all right I went away to attend to other matters. Presently came a distressful telegram that the machines had been thrown together and immediately had blown all the fuses. This was not as it should have been and I wrote back specific and exact instructions as to what was to be done. Result: Another telegram, longer and more lurid than the first one.

Then I got the engineer up over the long-distance telephone and talked to him "like a Dutch uncle," winding up by giving some specific instructions for overhauling the details of the wiring in the hope of finding the trouble. After waiting a while for results, I was about to take the train to the seat of war in person when a final despatch informed me that the trouble had been found. It turned out that the armatures were unsymmetrically connected, so that when put together in what to all appearances was the proper way the phases of the two machines did not correspond. The truth was discovered by running a small motor from the two machines separately and observing the astonishing fact that it ran in different directions according to the machine from which it was run. Instances of this sort are not likely to occur in the present state of the art, but it is not a difficult matter to get the circuits of polyphase machines twisted in hasty installations with a similar result.

I believe it is generally better in connecting phasing lamps for throwing machines in parallel to so connect them that when the machines are exactly in step the phasing lamp will be bright, not dark; preferably the lamp should be of a rather high voltage, so that when this condition is fulfilled it shall come to a bright cherry red, just sufficiently bright to be easily visible. Under these circumstances the interval or period of visible light is rather brief compared with the period of darkness while the machines are being brought into phase and the phasing is correspondingly sensitive. The advantage of phasing with a bright lamp is that in case the filament breaks during the process the darkness will not be mistaken for coincidence of phase. It seems almost a ridiculous caution, but this particular accident happened to a couple of big polyphase machines within my knowledge, and I am informed that the results were very striking.

In working from water-wheels there is very little danger of "pumping" between the generators. In engine-driven dynamos this phenomenon is more common and sometimes the governors have to be overhauled with extreme care in order to avoid it. Occasionally a synchronous motor or rotary converter may start to pump and cut back at the generator with rather formidable effect, but as a rule the station itself does not suffer much in this particular.

Most polyphase generators will be found to hold their voltage well under variations of load. The low-voltage generators, such as are used with raising transformers, are generally rather better in this respect than the high-voltage generators. The latter, whether for two or three phases, are frequently wound with only one coil per phase per pole, a construction which gives a rather high armature reaction which is unfavorable to close regulation. No system of compound winding, or its equivalent, has yet been applied successfully to the operation of large polyphase generators. In this particular they will be found considerably less easy to operate than large direct-current machines. The voltage must be held constant, either by hand regulation or by some form of automatic regulation applied either to the field of the generator or to the field of the exciter. Where the variations of load are not very rapid and the generator is possessed of good inherent regulation, there is little difficulty in holding the voltage excellently well by hand regulation alone. With the aid of a compensating voltmeter it is frequently easy to hold the voltage quite nearly constant at the sub-station.

If the load varies greatly, as in some cases of railway operation, or if the machines do not have good inherent regulation but are hypersensitive to changes of load, some form of automatic regulation is almost absolutely necessary. A number of devices to this end are in use with a fair degree of success. On the whole, I think the regulation is a little better in point of precision if it is applied directly to the generator fields themselves; although, if the changes of load are not too rapid extremely good results have been obtained from regulating the exciter fields, which is a somewhat easier matter.

It must be remembered in all polyphase working—in fact, in all alternating-current working—that precise holding of the frequency is just about as important as the accurate preservation of the working voltage, and a good working rule is to adjust the governors so as to hold the speed as accurately as possible under the changes of load and then to let them severely alone. This precaution is particularly necessary in stations from which many alternating-current arc lamps are operated, such lamps being sometimes unpleasantly sensitive to slight changes of frequency. Frequency indicators for switchboard use are now easily obtainable and are very useful pieces of apparatus in their way, particularly if the governors have to be adjusted for any cause, but they ought to be in a well-operated station useless ninety-nine per cent of the time.

In all polyphase stations and alternating stations in general the question of power factor is one which should be kept constantly in mind. At the present time power factor indicators are available, and such an instrument ought to find a place on every switchboard in a polyphase plant. For lighting business alone it is not a necessity, but practically such stations operate at least alternating arc lamps in considerable numbers, if not induction motors or synchronous motors, and rotary converters, and in all these cases the power factor of a station ought to be closely watched, for it indicates the extent to which the capacity of the generators is being needlessly used up. A little close attention to the changes in the power factor in connection with the load utilized by various customers will frequently result in locating some sinner who is mishandling his machinery and who should be sought out ahd labored with until reformed.

All this forms merely a sketch of some of the conditions which have to be daily met in the operation of polyphase stations. In a subsequent article I hope to take up some of the practical considerations relating to polyphase line construction and operation.

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TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

PRELIMINARY CONSIDERATIONS AS TO WIRE PLANT.

The term "wire plant" includes everything pertaining to the lines, from the wire or cable entrance at the office to the binding posts of the subscribers' instruments in the case of subscribers' lines, and to the wire or cable entrance at other offices in the case of a multiple-office exchange, trunk lines being then necessary. In towns and small cities the wire plant will nearly always consist of pole lines only; in medium-sized cities there will be some underground conduit, mostly in the neighborhood of the office and in the center of the business district, but no subscribers' connections will be made by means of underground laterals ("laterals" are branches from the main line of conduit to the houses and correspond exactly to the service wires of an electric light system); in such cases most of the subscribers are connected to the conduit from distributing poles upon which the underground cables terminate. In large cities a percentage of the wire plant will always be entirely underground, because in such cities a certain district is specified by the city authorities where all wires must be underground, including house connections.

Consequently, there are three distinct classes of wire plant to be considered, according to the size of the exchange. In small exchanges the whole wire plant will be overhead; in medium-size exchanges there will be an overhead district and a district in which the wires are partly overhead and partly underground, the mains being underground and the subscriber's connections overhead; in a large city, all three kinds will be found, an overhead district, a district of partly overhead and partly underground wires, and one in which all of the wires are underground. In the overhead district the construction will consist partly of "open wire" lines and partly of overhead cables; these cables should be used wherever possible, not only because such a policy cheapens the wire plant, but because the lines are better protected from accidental grounds and other disturbances. In the mixed district the mains will be underground, and these will include all trunk lines wherever there is more than one office, so that for trunk lines only underground construction will be assumed in the calculations hereafter given.

In cities containing alleys, the main runs will be connected to lines in these alleys by locating a distributing pole at the entrance of an alley, a cable being carried to a terminal box on the pole and open line-wire construction being carried thence through the alley, dropping off a pair of wires at the premises of each subscriber abutting on the alley. When there are no alleys, the distributing or cable pole may be planted at any convenient spot near a man-hole of the underground conduit system and from this pole lines may be distributed over house-tops and by means of poles set on subscribers' premises; in such cases, of course, the permission of property owners is necessary to the construction of the lines. As a rule, however, alleys exist and for distribution purposes they are always preferable; from an alley, subscribers facing on two adjacent streets can be reached from a single pole line and the crossing of a street to make a house connection is avoided.

In order to calculate the cost of the wire plant for any given city it is first necessary to determine how much of each of the three classes of construction is to be used. If the city authorities have not specified a district in which all wires must be underground, it is advisable to establish such a district for one's self, placing the limits so far out that there will be no occasion for the city authorities to complain within any reasonable time in the future. To determine accurately the exact amount of each kind of construction for any size of plant is impossible; recourse must be had again to the map on which the locations of the prospective subscribers have been plotted and the limits of the underground district laid out. It must be always kept in mind that for underground conduits, large runs, that is to say, conduits containing many ducts, are the cheapest, and similarly, in the case of pole lines it is most advantageous to load the poles heavily; therefore, it is a good policy to have a few main routes and make these very heavy. This result is best obtained by running the four main routes from the office in the four directions of the compass and feeding from each route on both sides. In cities where the alleys run only in one direction, either east and west or north and south, or in any other single direction, the best plan is to carry the main routes at right angles to the alleys, so as to feed from these into the alleys.

In laying out the wire plant it is absolutely necessary to be familiar with the local conditions of the city, such as lines of trees, locations of other pole lines and conduits, etc., which may render it impossible to follow out the best and most economical routes. After the routes for the main runs are once fixed the feeding lines will run at right angles to them. Just here it should be remembered that the use of diagonal streets slanting toward the office is sometimes economical, but only the lines on the side of the street that is farthest from the office should be run into such diagonal streets, as the lines on the side nearest the office have a shorter run to the main route parallel to the main streets. At the outskirts of the city, exchange lines begin at an anchor pole with open wires, and subscribers are collected from both sides until there are enough wires to start an overhead cable.

We will proceed under the assumption that there is only one office in the exchange. If there should be more than one office the same rules hold good for each office, except that in the office districts in the center of a very large city all lines may be underground. In modern practice only 50 open wires are run on a pole line, and if more are required a 25-pair overhead cable is started, which takes in 25 of the subscribers. In most cases a cable is started before the number of open wires reaches 50; only 30 open wires are usually run on a pole line. From time to time new cables are started, so as to leave the open wires always available for distribution. As soon as the underground conduit system is reached the overhead cables are, of course, carried down to the underground system and through that to the office. In some cases it is necessary to use small feeders underground, but it is advisable to never lay less than two ducts in a conduit, as it would cost almost as much to lay one as to lay two, and one duct should be provided any way for distribution. In such a case this duct serves the same purpose as the open wire line in the overhead district. The feeding into this distributing duct may be done through laterals or from hand-holes, or from distributing poles.

In laying out the cables, recourse is frequently had to multiple cabling for overhead as well as underground lines. To effect multiple cabling the cable is carried in its full capacity over a certain length and merely opened at distribution points, instead of decreasing the number of conductors at each distribution point by the number of subscribers fed from that point. By thus keeping the total number of conductors in the cable the same throughout a certain length, it becomes possible to use the same pair of wires at one or the other distribution point, making the system more flexible. In many cases it is not necessary to carry the full capacity of the cable to the end of the run, only a part of it may be multipled. The judgment of the engineer in this respect, assisted by a knowledge of local conditions, can produce great flexibility of plant without entailing unwarranted expense.

In considering overhead cables the weight of the cables must be taken into account. In most cases 50-pair cables are used in overhead construction, whereas in underground conduits space is valuable and cables of as many as 400 pairs are used. Care must be taken, however, not to carry such large cables over too long a run, as the wires must necessarily be of a smaller gauge than those in cables of fewer conductors, so that the resistance of the line may become excessive and even prohibitive for common battery service. The conductors in cables up to 200 pairs are usually No. 19 or No. 20 B. & S. gauge; in larger cables No. 22 is used. It seems that the latest practice in this respect points toward a general use of No. 22 gauge for cables, as the perfection of telephone apparatus is becoming such that there is practically no more difficulty in using this size of conductor throughout for common battery systems.

Another means of producing flexibility and reserve in the wire plant is to leave spare wires in the cables and spare cross-arms on the poles. When building a new plant it should be the rule to always leave about five spare pins on all open wire lines. In building new conduits it can never be predetermined precisely how many ducts will be required in each street, and as the cost of conduit per duct foot decreases as the number of ducts increases, it will be economical in the long run to provide at the beginning a spare duct capacity of about 30 per cent for ordinary conduits. If there are already many ducts in the conduit, 15 per cent spare capacity may be sufficient. The smaller the number of necessary ducts the larger should be the percentage of spare ducts.

With multiple cabling no spare cables should be allowed, but without multiple cabling an allowance of as much as one-third excess capacity is sometimes advantageous. In this connection, however, it must be remembered that a cable always contains a round number of pairs, either 25, 50 or 100, or multiples of these numbers, so that it will frequently be the case that the nearest standard number of pairs over and above the number that is actually required will afford sufficient spare capacity.

Cement for Pipe Joints.—At a recent meeting of the Ohio Gas Light Association in Columbus Mr. George Light recommended a cement for pipe joints, consisting of a mixture of ordinary pine tar and dry oxide of iron. This cement, Mr. Light stated, is as good in a faced or rough flange joint as red-lead putty, costs about one-tenth as much, does not harden as quickly as red lead, and is very adhesive under pressure.

Modern Practice in Rocking Valves and Valve Gears.

BY H. F. SCHMIDT.

As the fundamental features of Corliss valves and valve gears are doubtless well know to all readers of this paper, very little space will be devoted to a discussion of these features, which consist briefly of the use of four cylindrical rocking valves on each cylinder, the exhaust valves being driven positively and the steam valves opened positively but released during the stroke by auxiliary mechanism and allowed to close under the influence of vacuum pots or other means. It may be interesting, however, to consider some of the different types of valves and valve gears employed in modern steam engine practice, together with the reasons for the modifications of the original Corliss type of valve and gear.

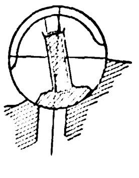


FIG. 1.

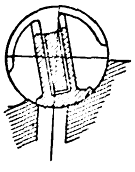


FIG. 2.

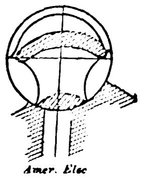


FIG. 3.

The simplest and possibly the most generally used form of admission valve and seat is that illustrated by Fig. 1, which is known as the single-ported type. As the illustration shows, the valve itself is a segmental casting, which is rocked to and fro on a circular seat by the twisting movement of the valve spindle. The inner end of the spindle is adapted to engage the central rib of the valve, through the medium of which it imparts the rocking movement to it. Fig. 2 illustrates a form of single-ported valve which is used extensively in Europe. This differs from the valve shown by Fig. 1 merely in having two transverse ribs between which a flattened portion of the valve spindle fits. Still another single-ported valve is shown by Fig. 3, the feature of which is that an opening is provided through the center of the valve rib, giving more direct admission of steam to the cylinder port.

Owing to the large sizes in which Corliss engines are now built, and the shorter travel required by the Trick and double-ported type of valves, a large number of manufacturers have been led to adopt them for both the steam and exhaust valves, though some builders use them for the exhaust alone, while still others do not favor their use for either. Fig. 4 shows the Trick valve, the advantage of which is that it admits of a given port opening being obtained with but little more than half the travel required with the single-ported type; Fig. 4-a is a modification of the Trick valve. Figs. 5 and 6 show two different styles of double-ported valves, and represent the forms most used by builders in this country, Fig. 5 being the form most used for the steam valves, and Fig. 6 that commonly used to control the exhaust.

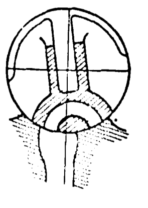


FIG. 4.

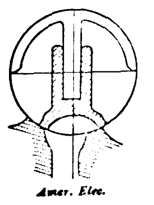


FIG. 4-A.

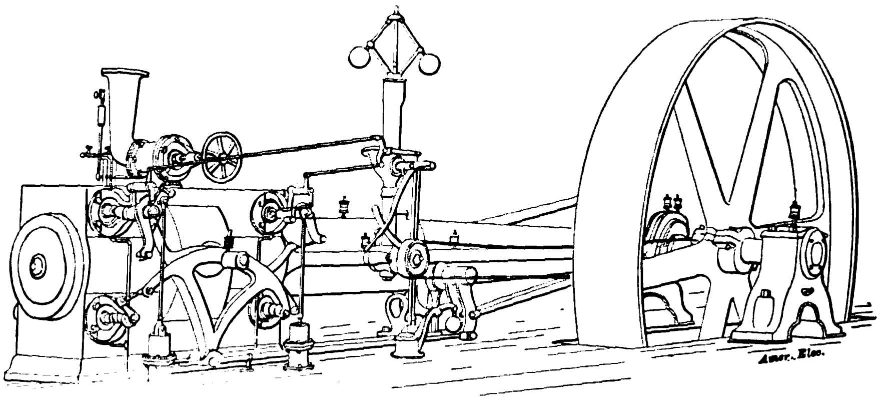


FIG. 7.—ORIGINAL CORLISS ENGINE.

The valves in horizontal engines are generally placed on the side of the cylinders, the steam valves above, and the exhaust below, so as to allow any water which has accumulated to escape by gravity when the exhaust is opened. In vertical engines the practice most frequently followed is that of placing the valves in the cylinder heads, this arrangement possessing many advantages for large vertical engines, among the most important of which is the simplification of the cylinder patterns and castings.

The original George H. Corliss engine is manufactured by the International Power Company, Providence, R. I. A general view of the valve gearing is shown in Fig. 7, and the releasing gear is shown in detail in Fig. 8. The rock arms, as may be seen from Fig. 7, are quite different in appearance from those now generally used, but are in effect almost the same, and impart to the grab hook a motion which is almost perfect for the object sought, and which cannot practically be obtained by any radically different mechanism.

The construction and operation of the releasing gear are as follows: The bell crank lever *A* carries a hook *C*, pivoted at *P* and held in position shown by the spring *S*. The drop lever *B* is keyed to the valve spindle and is connected to the dash pot by the usual link rods. The slotted bar *D* is connected to and is controlled by the governor through the lever *E*, its function being to control the point of release. As the lever *A* moves in the direction of the arrow, the hook die on the link C engages with the tip of the drop lever *B*, and lifts it till the pin *T* strikes the inner end of the slot, releasing *B*, which is then rapidly drawn down by the action of the dash-pot. The point of release is controlled, as before mentioned, by the position of the slotted bar *D*, the position of which is governed by the load on the engine.

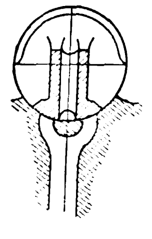


FIG. 5.

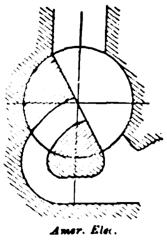


FIG. 6.

One of the reasons why the original gear has been modified to those which are hereafter to be described, is that the work of releasing the drop lever was thrown directly upon the governor, with the result that unless it was very heavy and ran at high speed, the regulation was often considerably affected. The releasing gear, as seen by the cut, was also unnecessarily complicated, especially the method by which the governor controlled the point of cut-off.

Figs. 9, 10 and 11 show in principle the form of releasing gear used by a large number of manufacturers, both in Europe and America. In the engravings, *A* is a bell-crank lever mounted loosely on the valve stem or on a projection of the bonnet, and carries the grab hook *H* at one end and is connected to the wrist plate by an adjustable connecting rod, from which it receives its motion. The hook *H* is normally pressed inward by the spring *S* so that the longer

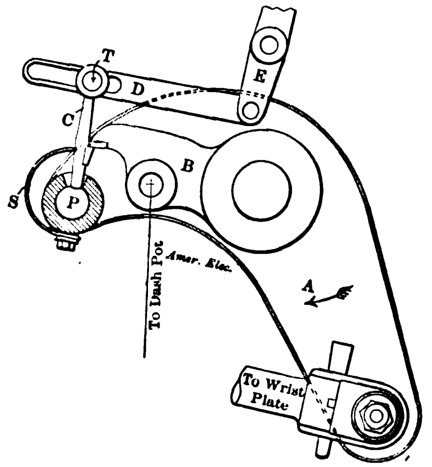


FIG. 8.

arm of the hook is always held firmly against the knock-off cam *C*, which is placed next to the bell-crank and is connected to the governor by a reach rod. The drop lever *B* is keyed to the valve stem and connected to the dash-pot by a rod; it carries a steel block or die which engages with the block or die on the grab hook *H*. As the bell-crank *A* moves in the direction of the arrow (Fig. 9) the hook is engaged with the die on the drop lever *B*, and as their relative positions remain constant, they having a common center of rotation, the end of *B* is raised, opening the valve, which remains open until the bell-crank has advanced so far that the longer arm of the hook *H* is pressed outward by the projection on the knock-off cam *C*, Fig. 10, when the drop lever *B* is quickly brought to its original position and the valve is thereby closed.

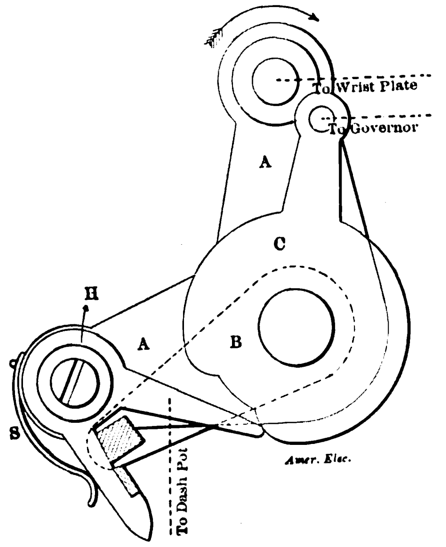


FIG. 9.

The action of the governor in changing the cut-off is to move the cam *C*, as shown in Fig. 11. Here the cam is shown in a position resulting in an earlier cut-off. Had the cam moved clockwise from its position in Fig. 9 or Fig. 10, a later cut-off would have resulted. This gear is very simple, and it will be seen that the work of releasing the drop lever *B* does not come on the governor, except to a very slight degree, not sufficient to be noticeable.

Fig. 12 illustrates a releasing gear of this type which was originally due to Mr. Edwin Reynolds, now chief engineer of the Allis-Chalmers Company, and which is used by the majority of American engine builders. The operation of the gear is precisely like that just described in connection with the elementary diagrams, Figs. 9, 10 and 11, except that an additional safety cam is provided on the same block which carries the knock-off cam. The function of this safety cam is to throw the grab hook out of reach of the die on the end of the drop lever in case the governor belt should slip or break, and thus prevent the grab hook from opening the valve. The gear here shown has become so widely used that it is now known as the standard Corliss release gear.

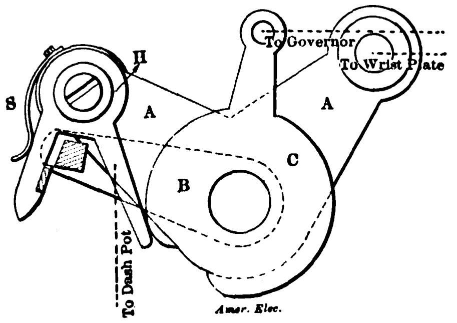


FIG. 10.

A favorite form of wrist-plate for operating the valve rock-arms or bell-cranks is the circular type shown in Fig. 13, which is self-explanatory. Another method of connecting the bell-crank levers with the wrist-plate is shown by Fig. 14. The difference between these two is that at the moment of opening the admission valves the travel of the bell-crank lever is much more rapid with the arrangement shown in Fig. 14 than with that shown in Fig. 13. With the under-type of bell-crank lever shown in Fig. 13, the angular motion of the valve spindle is almost uniform; with the over-type, illustrated in Fig. 14, the angle between the wrist-plate rods and the bell-crank levers is more acute when the valve starts to open than later in its travel, so that the initial movement is more rapid than the subsequent motion.

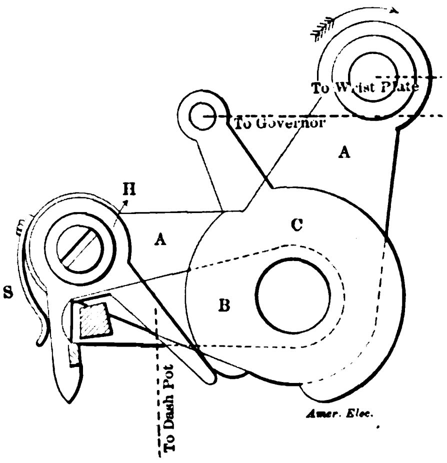


FIG. 11.

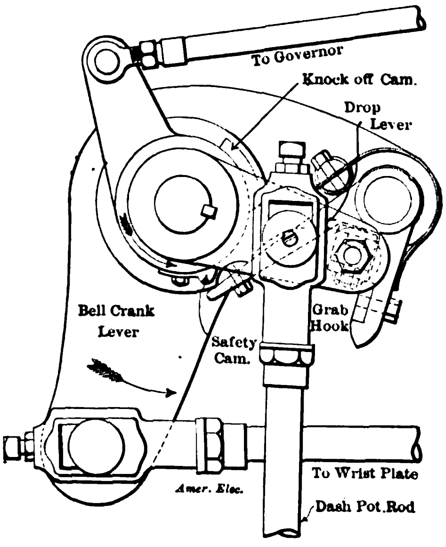


FIG. 12.

The single wrist-plate mechanism shown in Figs. 13 and 14 has the disadvantage of restricting the length of cut-off. The steam valves and the exhaust valves being actuated from the one wrist-plate, it will be evident upon reflection that a very late cut-off cannot be obtained without producing the result of having both the steam and the exhaust valves at the same end of the cylinder open simultaneously at a certain part of the stroke. Whenever longer range of cut-off is required than that necessary for ordinary operation, two wrist-plates are usually employed, one actuating the admission valves and the other the exhaust valves, and each wrist-plate being driven by an independent eccentric. The double wrist-plate arrangement with the plates mounted on a common spindle, as shown in Fig. 15, was originated, like the modern standard releasing gear, by Mr. Edwin Reynolds, and is widely used.

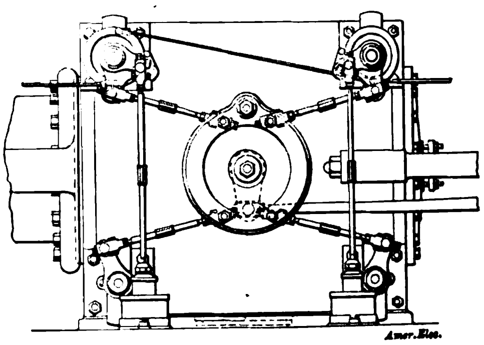


FIG. 13.—USUAL CORLISS GEAR.

The Edward P. Allis branch of the Allis-Chalmers Company, Milwaukee, Wis., employs this form of wrist-plate in conjunction with the form of releasing gear shown in Fig. 12. The bell-crank lever, however, is mounted on the end of a collar on the valve bonnet, and the knock-off cam block is mounted on the same collar, while the drop lever is mounted on the valve spindle between the end of the bonnet and the cylinder. This arrangement relieves the valve stem of practically all strain and eliminates the possibility of its becoming bent.

Fig. 16 illustrates the double wrist-plate arrangement used by the Frick Company, Waynesboro, Pa. This company also uses the standard form of releasing gear shown by Fig. 12. The dash-pot used by the Frick Company is shown by Fig. 17. As the plunger, *P*, is drawn upward by the valve gear, air is drawn into the plunger cylinder from the annular chamber, *A*, through the check valve, *C*. The air is not sufficient, however, to prevent the formation of a partial vacuum which draws the plunger quickly downward when the valve spindle is released. As the plunger nears the bottom

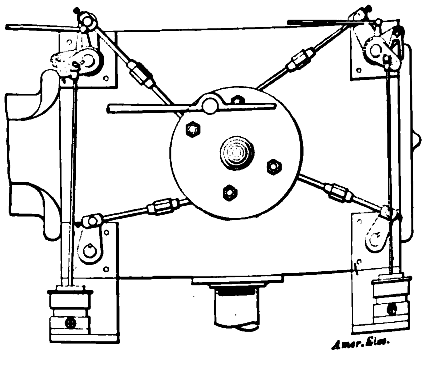


FIG. 14.—QUICK-OPENING GEAR.

of the cylinder it is cushioned by the air which has been drawn in from the surrounding chamber, and that air is forced back into the chamber through the poppet valve, *V*. The degree of cushioning can be accurately adjusted by means of the screw, *S*, and the helical spring between the lower end of the screw and the upper end of the valve spindle. The dash-pots are enclosed in annular spaces cored in the feet of the engine, as indicated in Fig. 16.

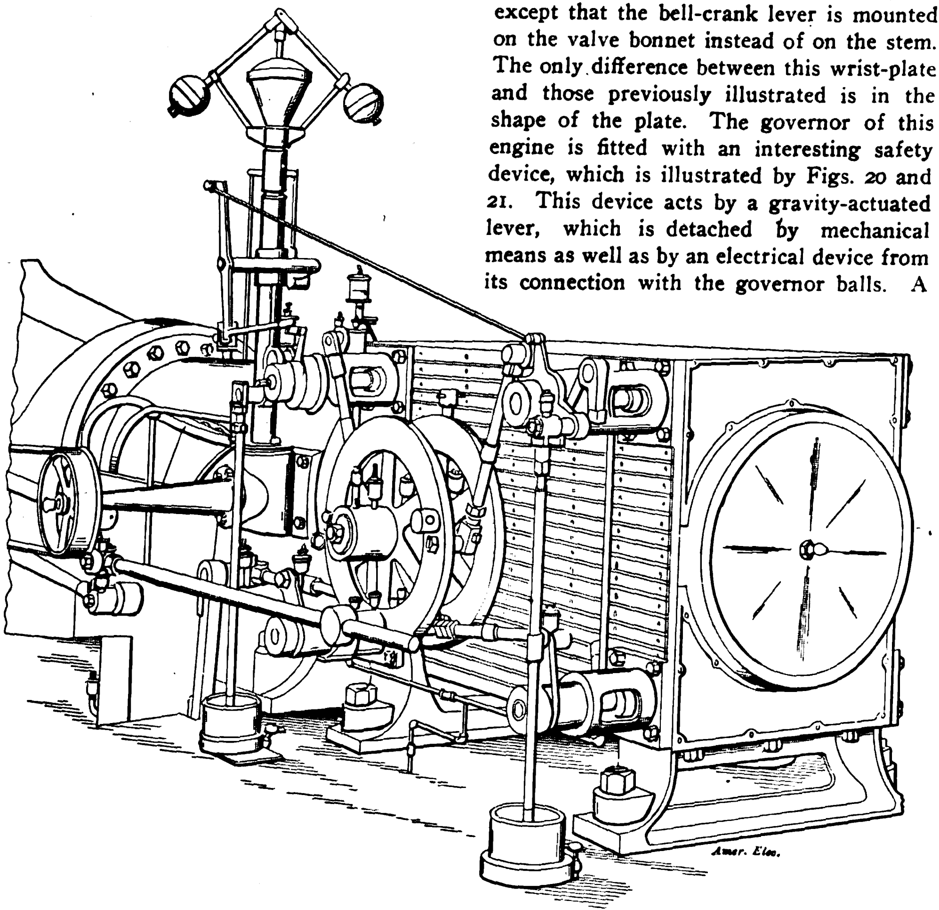


FIG. 15.—DOUBLE WRIST-PLATE "LONG-RANGE" GEAR.

In the Corliss engines built by Robert Wetherill & Co., Chester, Pa., the single wrist-plate and under-type bell-crank lever shown in Fig. 13 are used. The releasing gear is of the usual form, practically similar to that shown by Fig. 12, except that the bell-crank lever is mounted on a collar on the valve bonnet, so as to reduce the strain on the valve stem. The dash-pot used on the Wetherill engine is illustrated by Fig. 18. When the valve is opened, the plunger, *P*, is drawn up, forming a vacuum in the lower chamber, *E*, which closes the valve promptly. The upper end of the plunger is enlarged to form a plate, which fits closely the bore of the chamber, *F*, at the bottom of that chamber. The bore of the chamber, *F*, is enlarged immediately above the seat of the plunger head, however, so that the air can pass from the upper side to the lower as the plunger head rises. The clearance between the rim of the plunger head and the bore of the chamber however, is so small that when the plunger descends cushioning takes place as it nears its seat in the bottom of the dash-pot. The amount of cushioning is adjusted by means of the valve *G*.

Fig. 19 shows the arrangement of the valve-gear of the Corliss engine built by the Hewes & Phillips Iron Works, Newark, N. J. It will be observed that the single wrist-plate is used with the over-type bell-crank lever. The releasing mechanism is practically identical with that shown by Fig. 12, except that the bell-crank lever is mounted on the valve bonnet instead of on the stem. The only difference between this wrist-plate and those previously illustrated is in the shape of the plate. The governor of this engine is fitted with an interesting safety device, which is illustrated by Figs. 20 and 21. This device acts by a gravity-actuated lever, which is detached by mechanical means as well as by an electrical device from its connection with the governor balls. A weight falling moves the reach arms, bringing the cam into the position where the safety blocks prevent the valves from being opened, as in the gear shown by Fig. 12. By means of the electrical attachment the engine can be brought to rest from any part of the plant by merely pressing a button.

An important feature of the safety device is a gravity-actuated switch, which consists of two parts that are normally vertical when the governor is at rest, and which are raised by a projection on the guide arm when the engine is started, and lifted so that the center of gravity falls beyond the perpendicular, when they fall into the position shown in Fig. 21. This device puts the governor in a position of safety automatically, and makes it independent of the engineer, who might often forget to throw in the safety switch after starting up. There are two bronze cam plates, *C* and *D*, located on the extended hub of the governor bracket, one of which, *D*, is set in a position determined by the height the governor will run when the engine is running under no load. This cam is then locked fast by a set screw, so that the cam toe is slightly beyond the normal height due to the speed at no load. This cam need not be again moved, as it is not at all disturbed when it is in operation.

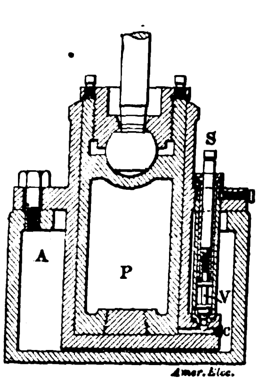


FIG. 17.

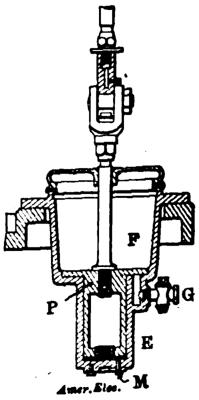


FIG. 18.

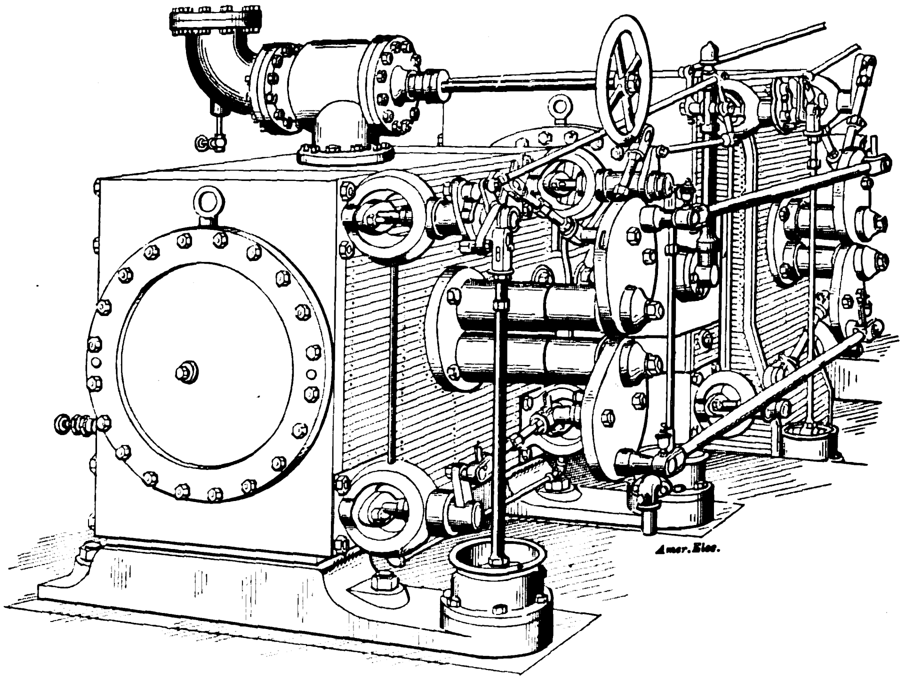


FIG. 16.—FRICK DOUBLE WRIST-PLATE GEAR.

The cam *C* is attached to a lever which is loose on a shaft supported by an arm of the bracket supporting the governor shaft. On one end of this shaft is keyed a hub having two projections which can engage with two similar projections on the lever just mentioned. On the other end of the shaft is keyed a lever carrying an idler pulley which runs on the slack side of the governor belt. If the belt should become too loose, run off the pulleys, or break, the loose pulley on the lever would be acted upon by gravity, turning the shaft and causing the projections of the hub and lever to engage, thereby forcing the rod *R* upward and turning the cam *C* forward. The toe of the cam *C* will then engage with the arm *B* of a latch, causing it to unlock and disconnect the lever from the governor balls. A heavy weight on this lever, acting through the cut-off cams prevents the valves from being opened. An electromagnet operated from any point in the plant detaches a weighted lever, which accomplishes the same object. The safety stop also acts by breaking the vacuum, thus insuring the stopping of the engine.

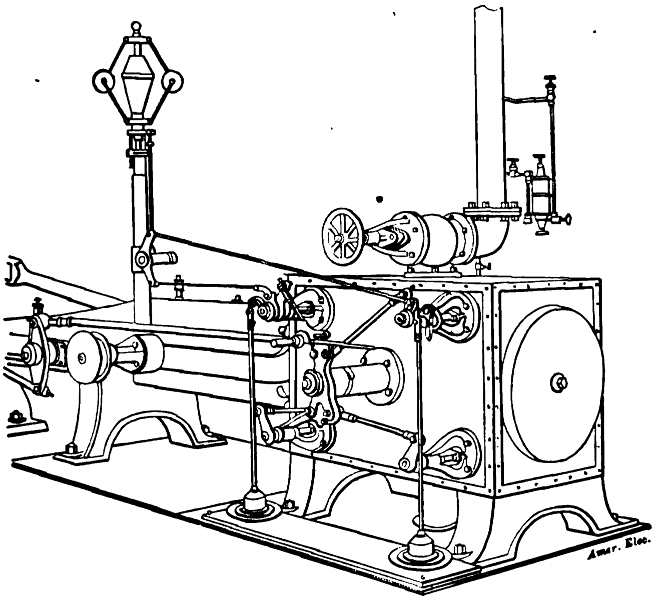


FIG. 19

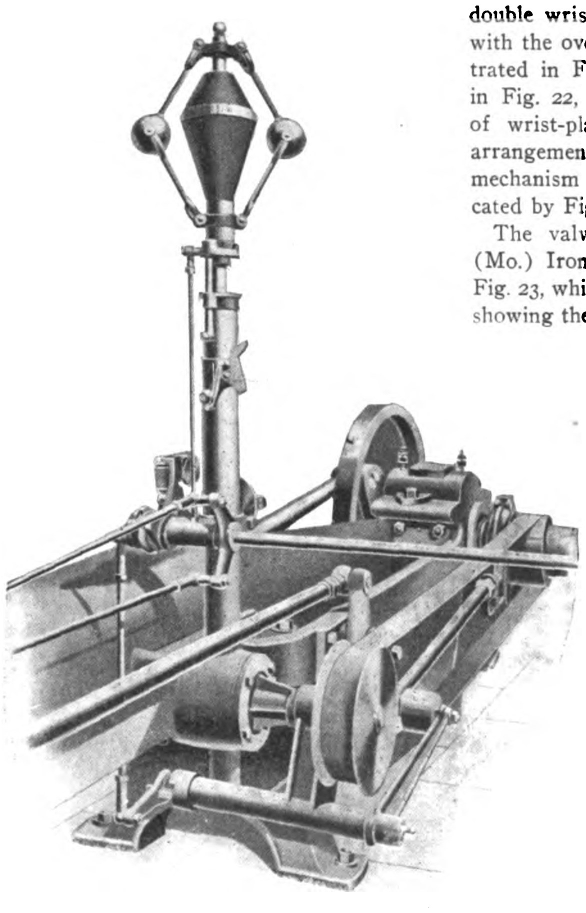


FIG. 20.

The valve-gear of the C. & G. Cooper Company's heavy-duty engine is of the double wrist-plate, long-range cut-off type, with the over-type of bell-crank lever illustrated in Fig. 14. The gear is illustrated in Fig. 22, which shows clearly the shape of wrist-plate employed and the general arrangement of the gear. The releasing mechanism is of the standard type indicated by Fig. 12.

The valve-gear used by the St. Louis (Mo.) Iron & Machine Works is shown in Fig. 23, which is a half elevation and section, showing the valve-gear and dash-pot of one-half of the cylinder and a longitudinal section of the other half. It will be noticed that the wrist-plate is of the single-disc type and the bell-crank lever is under-type. The whole gear is substantially the same as that illustrated in Figs. 12 and 13. The dash-pot is of somewhat unusual form. The plunger, *P*, is hollow, and fits tightly over a stationary hollow piston, *H*. When the plunger is drawn upward by the opening of the valve a vacuum is created on the interior of the plunger above the piston *H*. When the valve is released and the vacuum draws the plunger down again, cushioning is not effected until the flange on the bottom of the plunger *P* reaches the short cylinder, *C*, compressing the air below the plunger flange. The air escapes through the small opening, *L*, into the hollow piston, *H*, making the dash-pot noiseless.

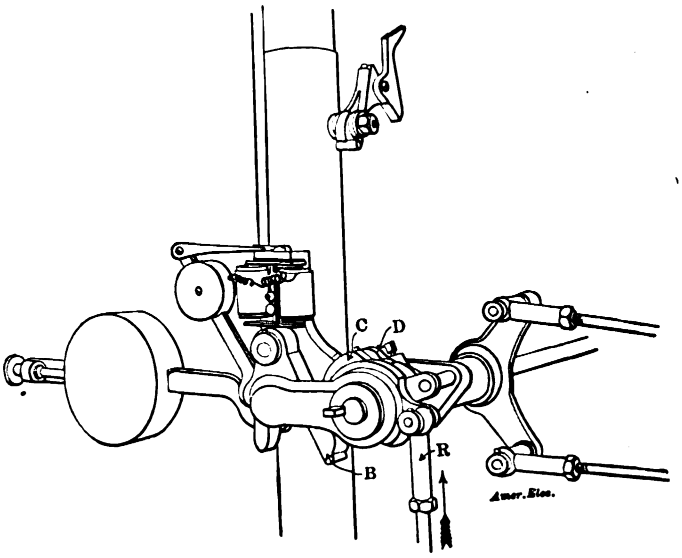


FIG. 21.

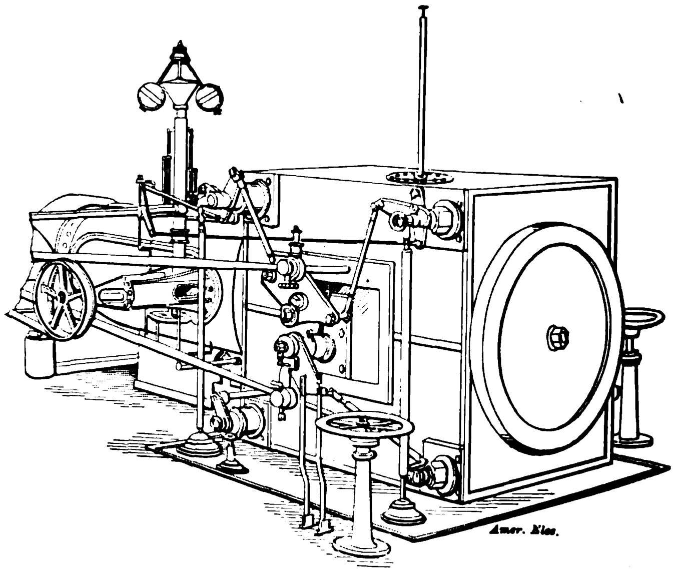


FIG. 22.

Fig. 24 shows the detaching gear of the Fraser & Chalmers branch of the Allis-Chalmers Company, Chicago. While of the type previously described, it will be seen that it differs in the shape and arrangement of its parts. Starting from the lowest position (not shown), the hook *H*, which is forced inward by the spring, engages with the drop lever *B*, and as the bell-crank lever *AA* moves in the direction indicated by the arrow, the lever *B* is carried around to the position shown, opening the valve.

When this position is reached, the trip lever *T* comes in contact with the projection *N* of the cam *C*, forcing it, and consequently the grab hook *H*, outward, and releasing the drop lever *B*, which is rapidly brought to its original position by the action of the dash-pot. The position of the projection *M* on the knockoff cam *C* is such that when the governor is in its lowest position it will occupy the position which *N* has in the figure, preventing the hook *H* from engaging with the drop lever *B*, which position it would instantly take should the governor belt slip, break, or run off the pulleys, shutting off the steam supply to the cylinder, and bringing the engine to rest.

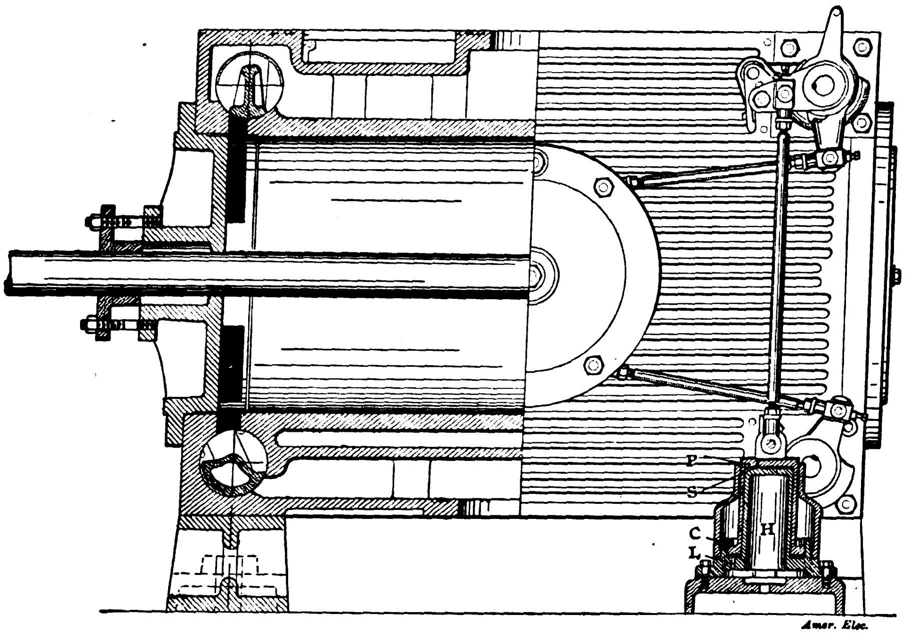


FIG. 23.

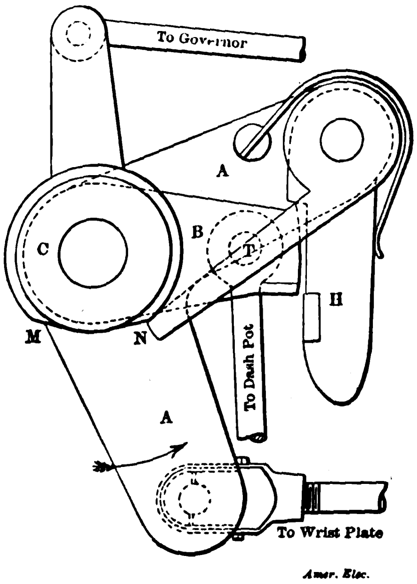


FIG. 24.

The Hooven, Owens & Rentschler Company, Hamilton, Ohio, manufacturer of the Hamilton-Corliss engine, use the form of valve-gear shown in Fig. 25, and also the double wrist-plate type shown by Fig. 15. The releasing gear is of the type of Fig. 12, with the bell-crank lever mounted on a projection of the valve bonnet to relieve the strain on the valve stem, as is now quite generally done.

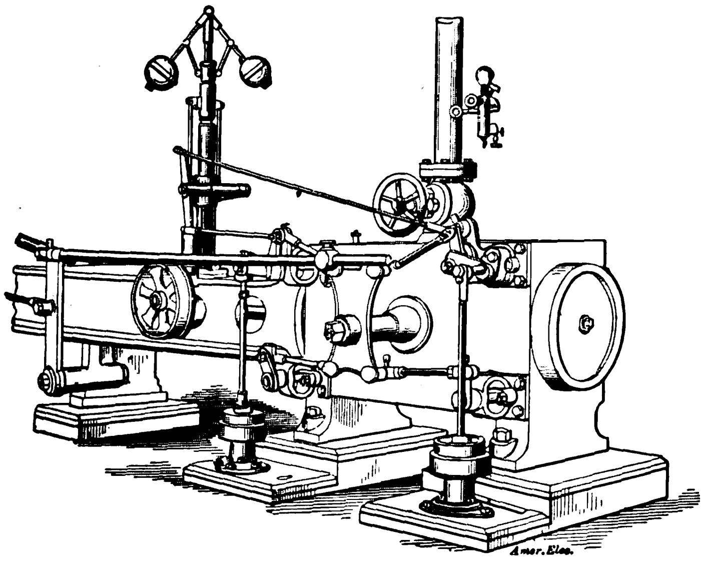


FIG. 25.

The Murray engine, built by the Murray Iron Works Company, Burlington, Iowa, is provided with the single wrist-plate overtype bell-crank gear of Fig. 14. The releasing gear of this engine is illustrated by Fig. 26. It is of substantially the såme construction as that shown in Fig. 12, but both the bell-crank and the knock-off cam are mounted on the end of the valve bonnet, so that there is no strain on the end of the valve stem except the absolutely unavoidable torque due to the operation of the valve itself. The governor, Fig. 27, is of the weighted Porter type, and the central weight is cast hollow at the upper end in order to allow the insertion of shot, by means of which a fine degree of adjustment is obtainable. The governor is provided with a dash-pot, as the engraving shows, in order to prevent see-sawing. Fig. 28 shows a cross-section through the valve-gear dash-pot, showing the plunger in its highest position. A vacuum is formed in the chamber, *A*, to draw the drop lever down when the valve is released, and cushioning is effected in the chamber *B*, into which air is drawn through the opening shown on the left. The cushioning takes place when the enlarged head of the plunger passes the slot on the left, the degree of cushioning being adjustable by means of the valve *V*.

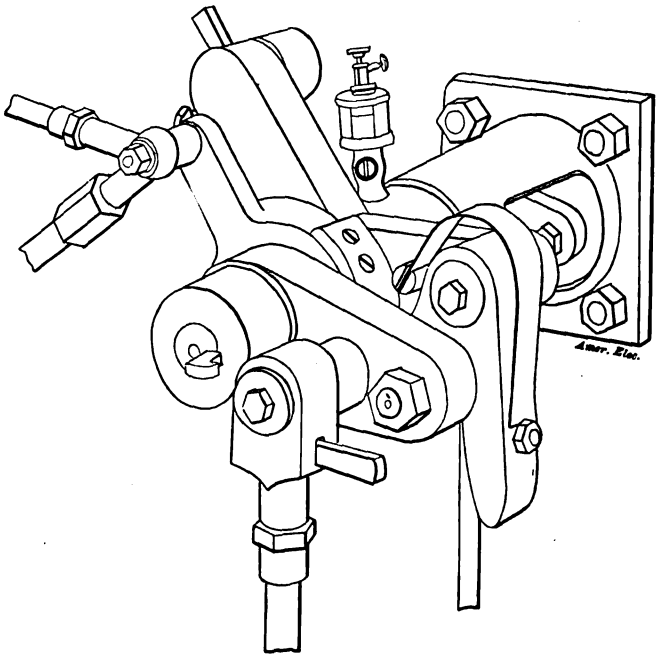


FIG. 26.

Fig. 29 shows the valve gear of the Newburg (N. Y.) Ice Machine & Engine Company's Corliss engine, which will be recognized as of the usual type, but with the grab hook mounted on the side of the valve spindle away from the wrist-plate instead of between the valve spindle and the wrist-plate. The bell-crank lever is of the over type, giving rapid opening of the admission valves. All of the parts are mounted on the valve bonnet except, of course, the drop lever, which is necessarily on the valve stem.

The valve-gear of the Pennsylvania Iron Works Company, Philadelphia, shown by Fig. 30, like the gear just described, has the grab hook mounted on the side of the valve stem away from the wrist-plate. The gear is of the short-range cut-off type, operated from a single eccentric, and two levers are used instead of the ordinary form of wrist-plate; this part of the gear is provided with an outboard bearing. Another feature different from the common practice is the use of a single reach rod from the governor to the gear, the arm of the knock-off cams being connected by a rod, as shown in the engraving.

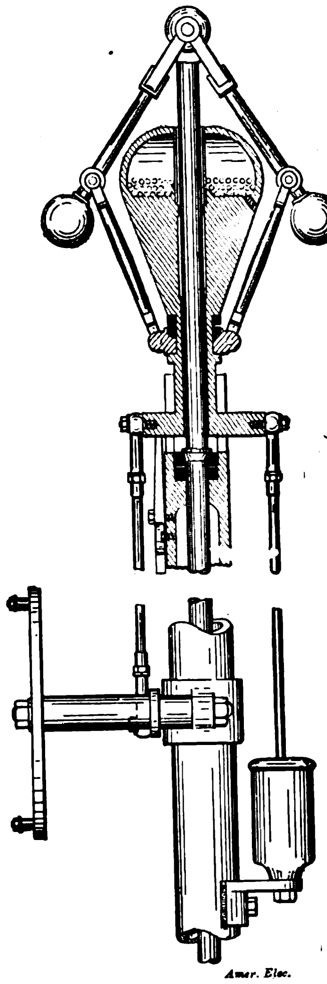


FIG. 27.

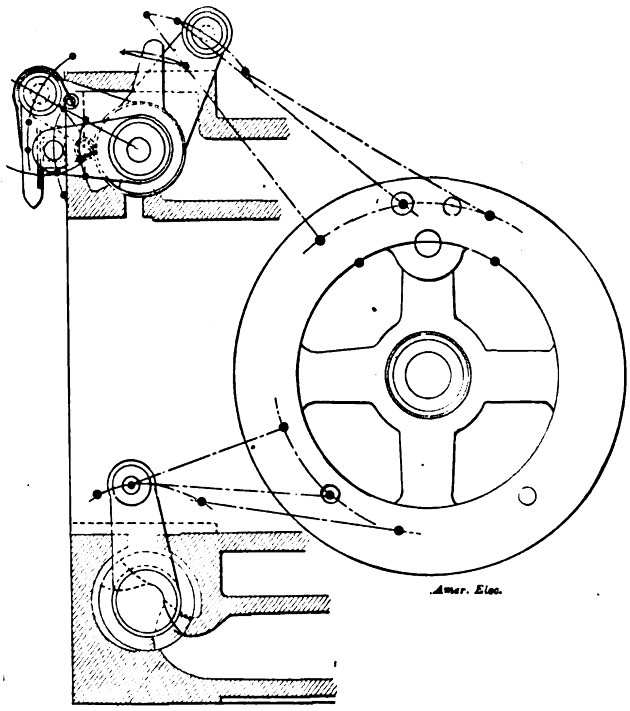


FIG. 29.

Fig. 31 shows one form of valve gear used by the Watertown (N. Y.) Engine Company, which will be recognized as the standard type illustrated by Fig. 13. The wrist-plate is of relatively large diameter, so that both the admission and exhaust valves are given a very rapid motion. The steam valves are of the modified Trick type illustrated by Fig. 4-a, and the exhaust valves are of the double-port type. The use of these valves renders a short throw possible, and therefore reduces the velocity of the valve gearing.

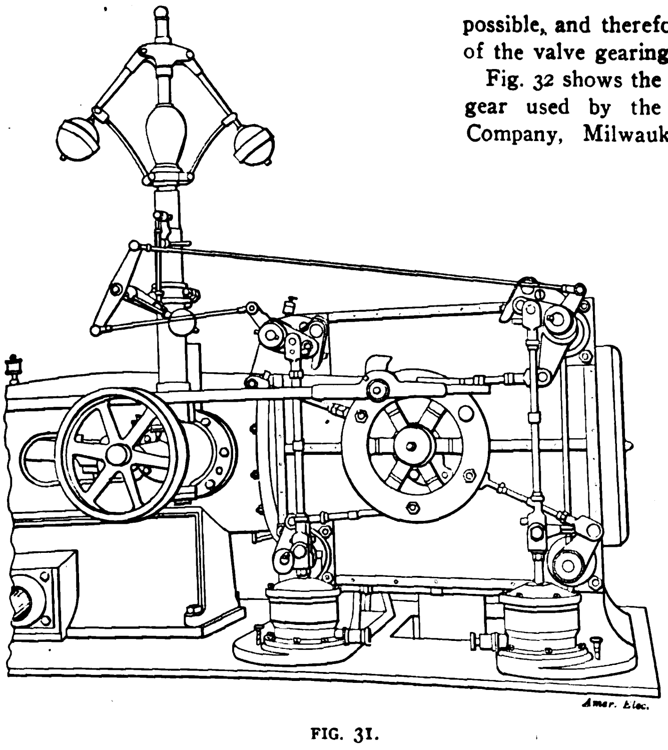


FIG. 31.

Fig. 32 shows the standard type of valve-gear used by the Vilter Manufacturing Company, Milwaukee, Wis. It will be noted that the general appearance is very much like those already shown, but there are a considerable number of minor details which differentiate it from others. The grab hook swings *outward* to engage with the die; this makes the gear more compact, and makes the die on the grab hook accessible for wiping while the engine is running.

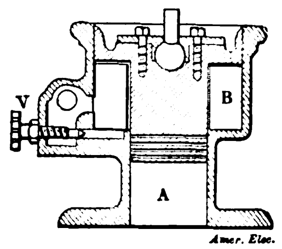


FIG. 28.

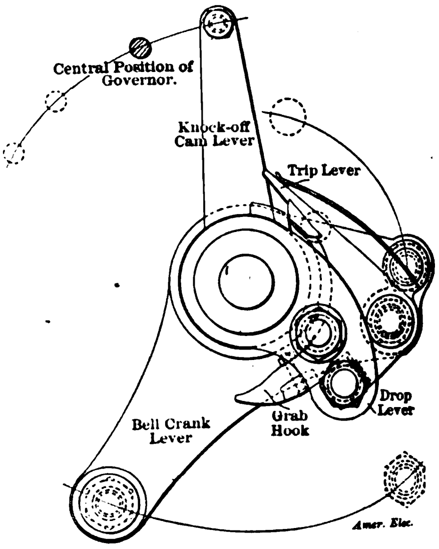


FIG. 32.

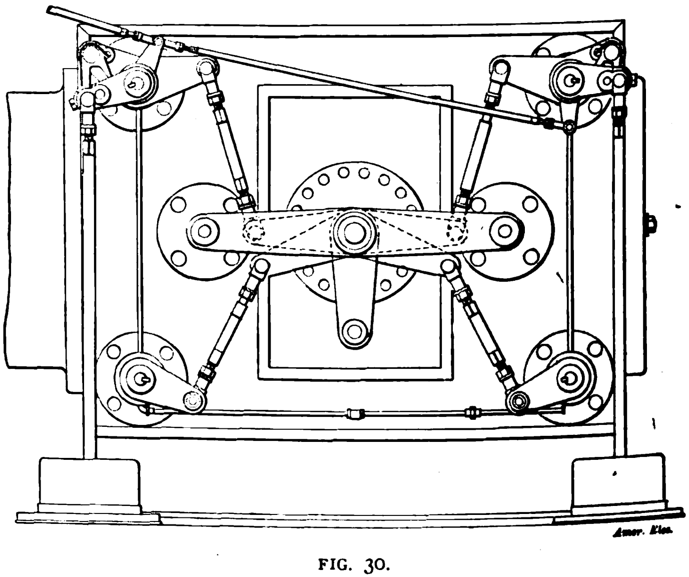


FIG. 30.

The single wrist-plate is used. The construction of the Vilter dash-pot is shown by Fig. 33. The plunger, *P*, is hollow, and fits snugly the outside of a stationary piston, *p*. When the plunger is raised air is admitted beneath it from the chamber *A*, through the valve *B*, and a partial vacuum is formed inside of it between the head of the plunger and that of the stationary piston *p*. The degree of vacuum obtained is adjusted by means of the valve *C*. When the plunger descends it is cushioned by the air beneath it, which is forced back into the chamber *A*, and also by the small amount of air admitted through the valve *C*. As the plunger settles home this small quantity of air is forced out at the valve *D*, the exit by way of the valve *C* being too slow for practical operation.

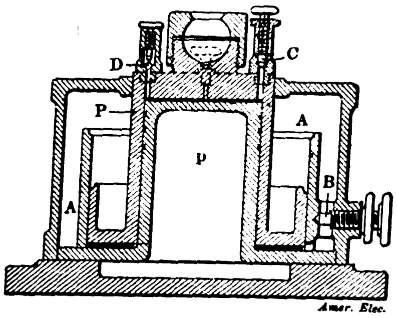


FIG. 33.

A very wide and successful departure from the standard type of release gear is that shown in Figs. 34 and 35. This is used on the Atlas Corliss engine, built by the Atlas Engine Works, Indianapolis, Ind. The releasing gear is unique in that inertia, centrifugal force, and the force of gravity (which never fail) are relied upon to operate the grab hook. The hook, *H*, and trip, *C*, are made comparatively massive, and the weight is so distributed that when the hook is down ready to engage with the die, *d*, on the drop lever, the kinetic reaction of the lever on the reversal of the direction of motion, centrifugal force and gravity (due to the position of the center of gravity of the grab hook not being in a perpendicular through the pivot) throw the grab hook outward positively, never failing to engage at even the highest speeds, as the forces tending to make the hook engage are increased as the speed is increased. The release is determined by the governor through knock-off cams, as usual, and safety cam blocks are provided. The method of attaching the wrist-plate rods is such that the motion is imparted to the drop lever in a line almost parallel to the dash-pot rods, thus reducing very greatly the strains on the valve bonnets.

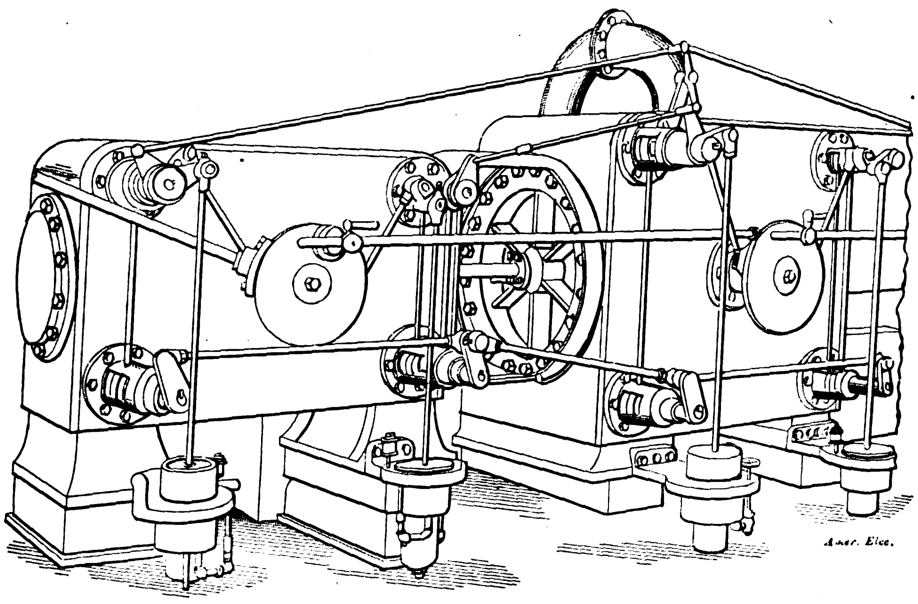


FIG. 34.—DIRECT-ACTING EXHAUST-VALVE GEAR

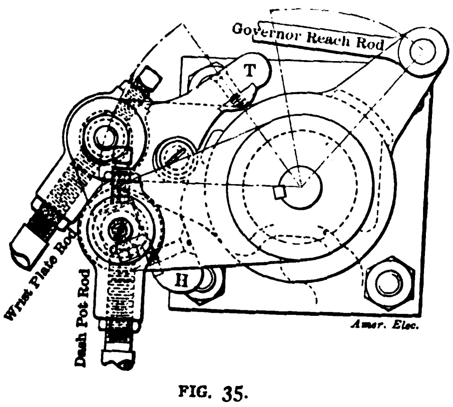


FIG. 35.

The modified form of Trick valve, Fig. 4-a, is used. The exhaust valves are of the double-ported type, and both the steam and exhaust valves are located in the cylinder heads and finished separately from the body of the cylinder, very much like the usual practice in vertical engines. Long-range cut-off is obtained by the use of two eccentrics, but in place of two wrist-plates one wrist-plate is used on each cylinder to operate the steam valves, while the exhaust valves are all connected by link rods, which are in turn directly connected to the eccentric rod, as shown in Fig. 34.

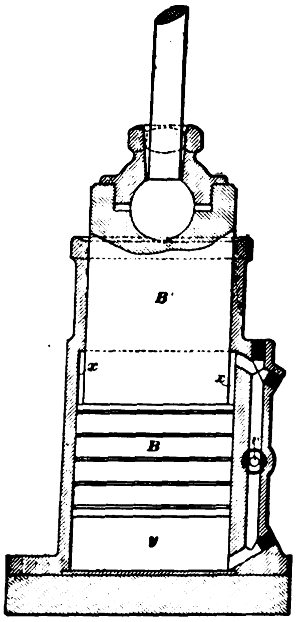


FIG. 37.

The valve-gear of the Fishkill Landing (N. Y.) Machine Company's engine is driven by a single wrist-plate, and under-type bell-cranks are used, as in Fig. 13. The releasing gear used on this engine is shown by Fig. 36. The operation is essentially the same as that of the standard Corliss type; the chief difference lies in the form of the knock-off mechanism. In place of the usual knock-off cam there is a ring having three projecting arms, one of which, *H*, is connected to the governor by the reach rod *Z*. Of the two other arms, the arm *j* carries a roller at its end and the other a cam, *W*, which is adjustable, and takes the place of the usual safety cam on the knock-off cam block. The gear is shown in its upward movement, the grab hook *E* being engaged with the drop lever *C*. As the grab hook moves upward, the roller *R'* comes into contact with the roller *R*, which forces *R'* outward, and thus releases the drop lever, which is then drawn down by the dash-pot as usual. The action of the safety cam

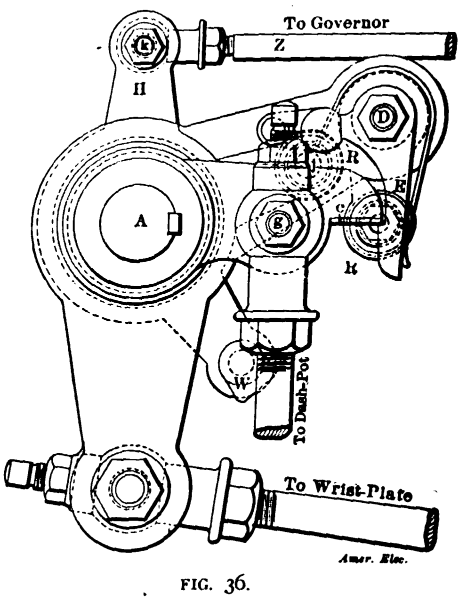


FIG. 36.

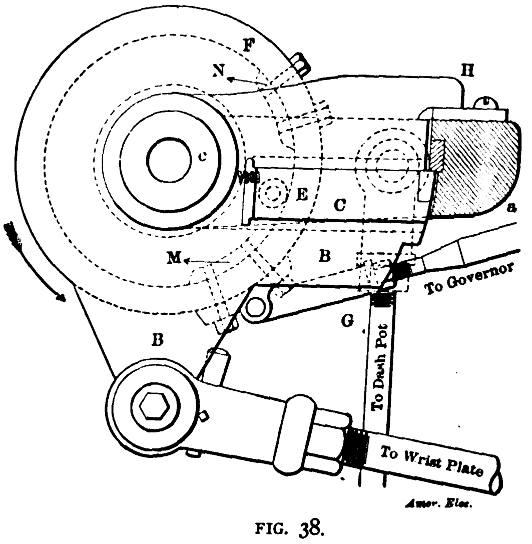


FIG. 38.

W is the same as in the ordinary releasing gear.

Fig. 37 represents the dash-pot, which is of the combined vacuum and pressure type. The air is compressed in the annular space *x*, and a vacuum is formed in *y* as the plunger rises, which combine to draw the plunger down when the drop lever is released. As the plunger descends it cushions on air in the chamber *y*, coming quietly to rest, and as the air is entirely confined the action is noiseless. The valve *y* regulates the amount of air admitted to the cylinder *y* for cushioning.

An extremely simple form of releasing gear is that employed on the engine made by the Bass Foundry & Machine Company, Fort Wayne, Ind. The construction and operation of the gear will be readily understood by inspection of Fig. 38. The grab hook consists of a block, *C*, sliding in a grooved slot in the bell-crank lever *BB*, and normally forced outward by a spring. The block *C* carries a pin, *E*, on the rear side, which is held in contact with a cam ring *F*, having two knock-off dies, *M* and *N*, on its inside surface. As the bell-crank moves in the direction of the arrow from the position shown, the roller on the pin *E* strikes the cam die *N*, and is forced rapidly inward, releasing the drop lever *a*. If from any cause the dash-pot should fail to act, the projection *H* on the bell-crank lever would engage with the drop lever and close the valve. This is provided for in almost every form of releasing gear, but has not been previously mentioned. The strains from the wrist-plate and dash-pot rods are borne by the valve bonnet.

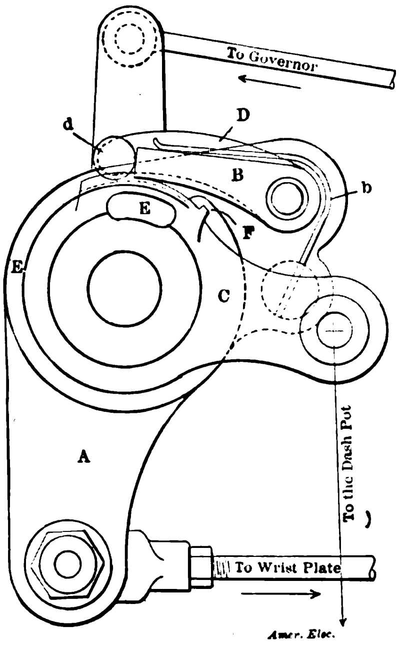


FIG. 41.

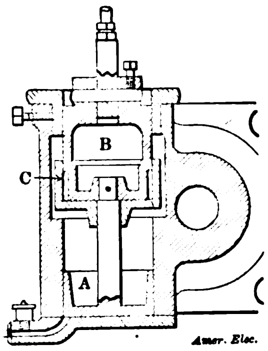


FIG. 42.

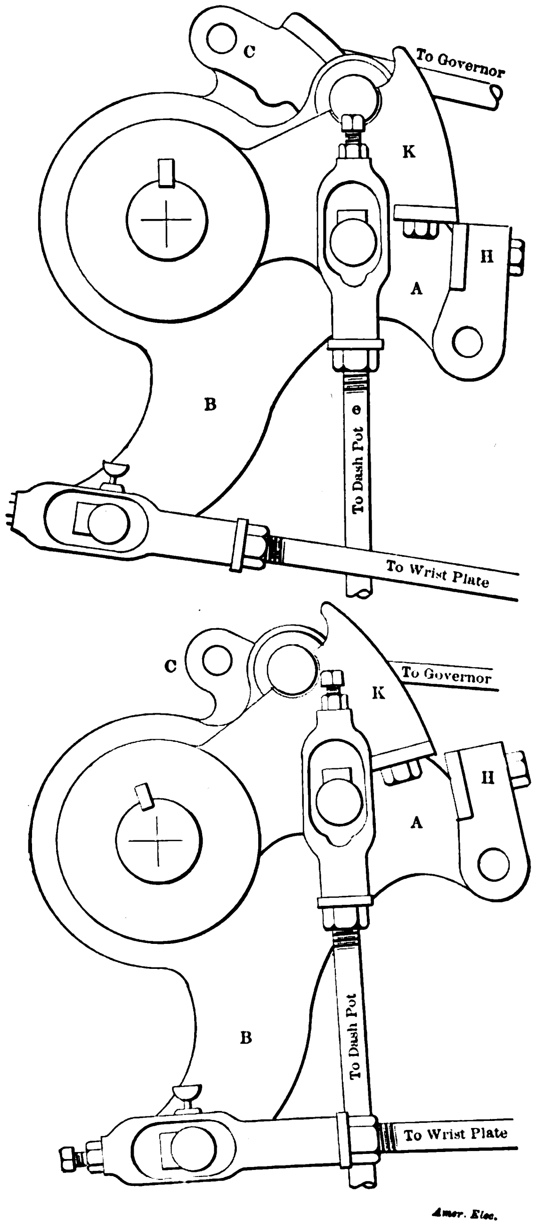


FIG. 39.

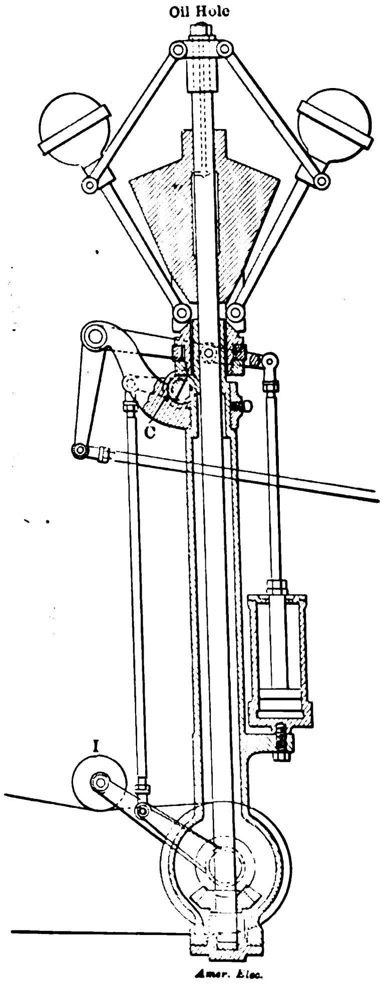


FIG. 40.

In Fig. 39 is shown the detaching gear of the engines manufactured by The Filer & Stowell Company, Milwaukee, Wis. The operation of this gear, which is in some respects very similar to the standard Corliss type, will be readily understood by reference to the illustration, where *B* is the bell-crank, which carries the hook, *H*, mounted on a short shaft, on the other end of which is the trip lever which engages with the knock-off cam *C*, operated, as usual, by the reach rod from the governor. When the bell-crank reaches the lowest point of its travel the hook *H* engages with the drop lever *K*, raising it until the trip lever en-

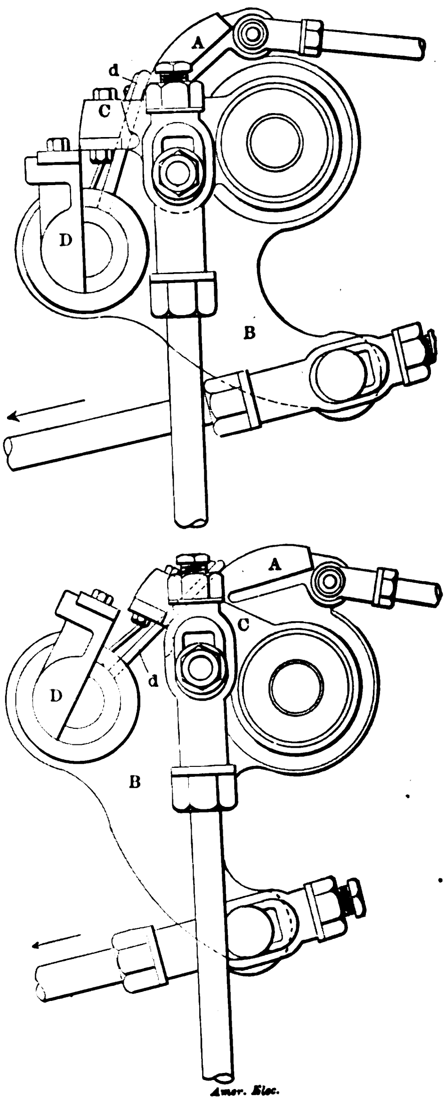


FIG. 43.

gages with the knock-off cam, throwing *H* outward and releasing the drop lever, which is drawn down by the dash-pot, as usual. When the governor reaches its lowest position the knock-off cam is drawn over to the right into such position that the trip lever engages with it, preventing the hook from raising the drop lever, and thus bringing the engine to rest.

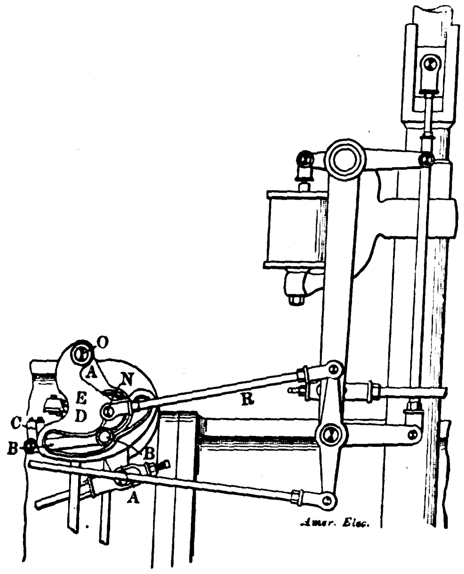


FIG. 44.

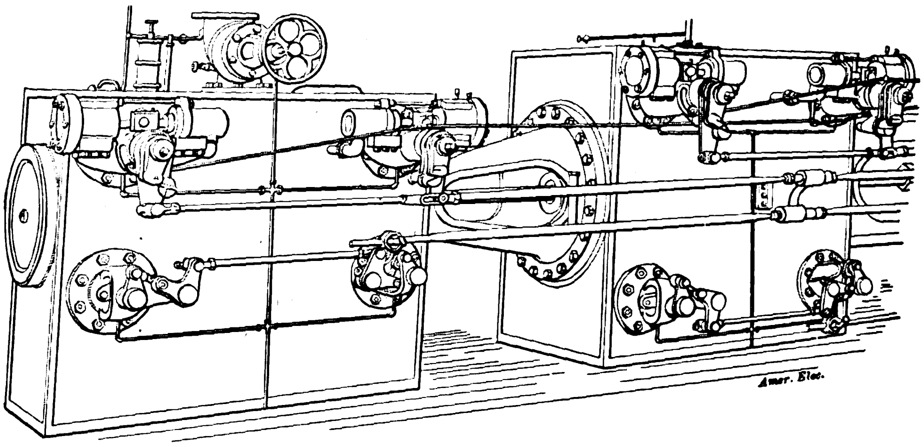


FIG. 45.—AUXILIARY BELL-CRANKS, INSTEAD OF WRIST-PLATES.

The governor is of the weighted Porter type, and has a dash-pot to prevent unstable action. It is fitted with the ordinary safety device, consisting of an idler pulley running on the governor belt, and arranged to cause the knock-off cam to be thrown into the safety position, in case the governor belt breaks or runs off the pulleys. Fig. 40 shows the governor and safety stop. Should the idler, *I*, drop, the catch *C* will be turned so as to allow the governor to drop to its lowest position, with the above result.

Fig. 41 shows the type of releasing gear used on the engines built by the Philadelphia (Pa.) Engineering Company. The release mechanism consists briefly of a bell-crank lever, *A*, which carries the pawl *B*, mounted on a short shaft, on the other end of which is a curved trip lever, *D*. The pawl *B* is normally held in contact with the cam *E*, which forms part of the drop lever *C*. Starting from the lowest position of the bell-crank, the pawl is engaged with the drop lever, raising it as the bell-crank moves in the direction of the arrow, until the roller on the end of the trip lever strikes the releasing projection on the knock-off cam, throwing the pawl *B* outward, and releasing the drop lever *C*.

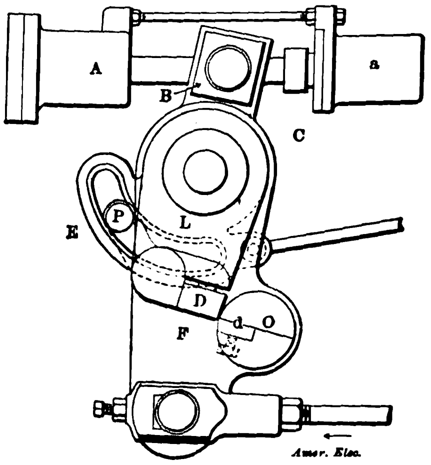


FIG. 46.

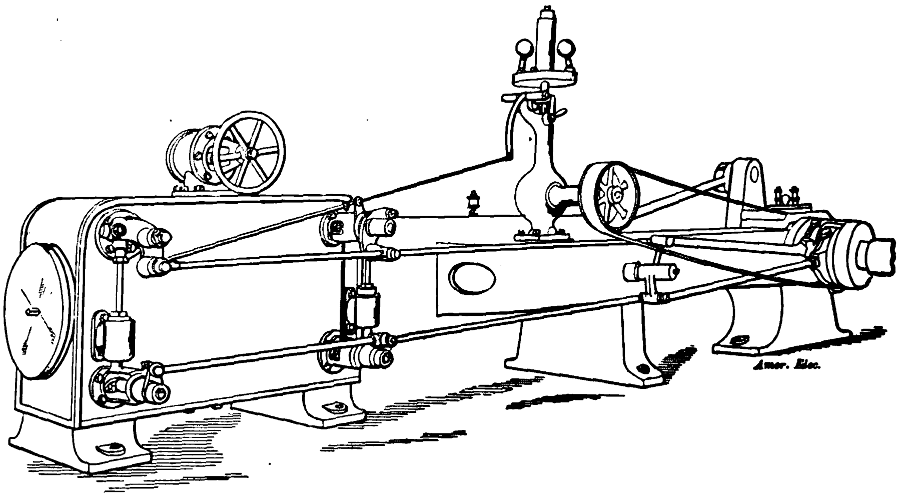


FIG. 47.—DIRECT-CONNECTED VALVE-GEAR.

When the governor is brought to its lowest position the roller on the trip lever rides on the highest position of the knock-off cam *F*, to the right of *E*, preventing the hook *B* from engaging with the drop lever, and thus preventing the opening of the valves. It is stated that the action of gravity on the pawl *B* and the tripping lever *D* is sufficient to keep the pawl engaged with the cam *E* on the drop lever without the use of the spring *b* for speeds below 90 r.p.m., but it is not advisable to depend upon the action of the gravity alone, because this force is hardly sufficient when the dies become worn.

The dash-pots used are of rather unusual design, as shown in section in Fig. 42. When the plungers *A* and *B* rise, a vacuum is formed under *A*. When the plungers descend, and the shoulder on the plunger *B* reaches the cylinder *C*, air is caught in *C*, cushioning the valve in the usual manner.

The Nordberg Manufacturing Company, Milwaukee, Wis., uses the form of releasing gear shown in Fig. 43. It consists principally of a curved bell-crank, *B*, carrying the grab hook *D* mounted on a short shaft having an arm at the other end. The trip lever *d* rides on the knock-off cam *A*, the position of which is controlled by the governor, as usual. When the bell-crank reaches the position shown in the upper sketch, the trip lever is thrown outward, releasing the drop lever, the point of release being governed, of course, by the position of the knock-off cam. This construction permits of a slightly longer cut-off under the control of the governor, as the eccentric is set nearer 90° with the crank than is usual under the conditions of the ordinary Corliss type of gear.

Fig. 44 is another form of releasing gear used by the Nordberg Company. This gear was designed to give a range of cut-off to eight-tenths stroke under the control of the governor, and by the use of a single eccentric. The manner in which this effect is obtained is by pivoting the knock-off cam *E* at *O*, on the bell-crank lever *A*. The reach rod *R* is attached to the cam *E* at *N*, almost coincident with the center of rotation of the bell-crank lever, hence, as the cam can rotate with the bell-crank, it is evident that the limitations of the ordinary releasing cam are obviated.

Fig. 45 shows a side view of the cylinders of a tandem-compound Corliss engine built by the Harrisburg Foundry & Machine Works, Harrisburg, Pa. The principal feature of the design, from a general point of view, is the absence of wrist-plates, the valves being operated through the action of auxiliary bell-crank levers which are rocked directly by the eccentrics. The arrangement and design of the dash-pots also present a novel appearance.

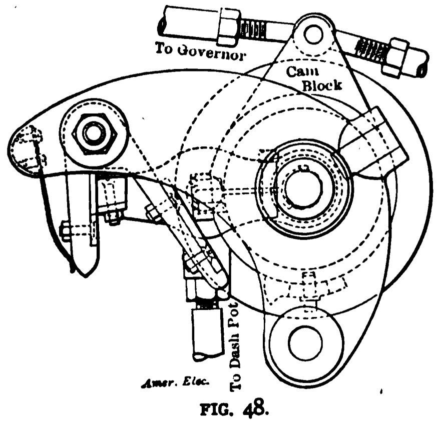


FIG. 48.

The detaching mechanism, which is of an extremely simple design, is shown in Fig. 46. The crank *F* carries a semi-circular pin, *O*, having a die, *d*, which engages with the lug *D* on the drop lever *L*, opening the valve as the crank *F* moves in the direction indicated by the arrow. When the point of release is reached, the pin *P*, moving in the slot of the knock-off cam *E*, is forced outward, thus moving *D* inward, and releasing the valve, which is closed by the combination dash-pot. This consists of two cylinders, *a* and *A*, bolted on the side of the cylinder. The cylinder *a* is connected to the steam chest, the pressure on the plunger replacing the ordinary vacuum, while the cylinder *A* cushions the motion of the valve.

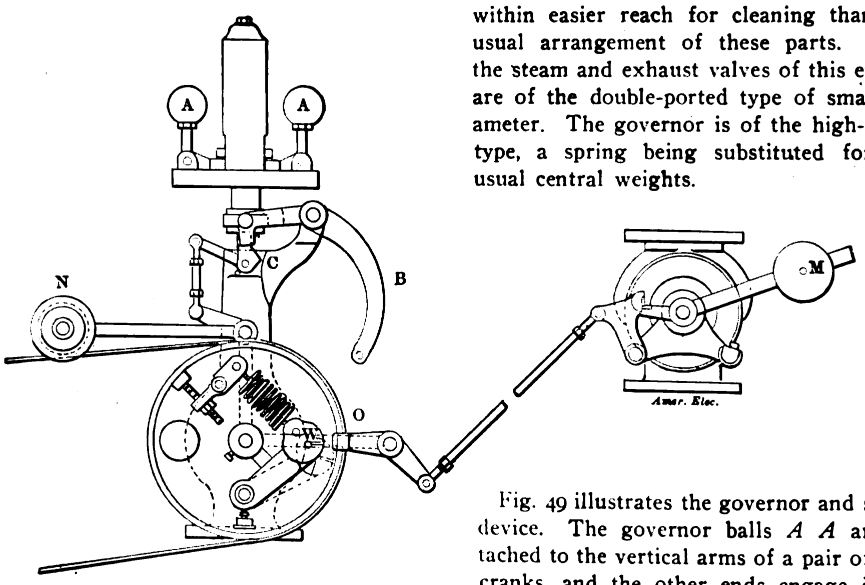


FIG. 49.

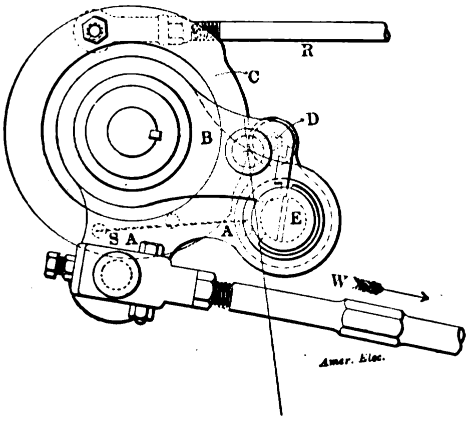


FIG. 50.

The valve-gear of the heavy-duty engine built by the Lane & Bodley Company, Cincinnati, Ohio, is also devoid of wrist-plates. Fig. 47 shows this gear, from which it will be evident that all of the valves are driven directly by reach rods from the rock arms at the ends of the eccentric rods. Another feature of this gear which tends to differentiate it from the ordinary is the location of the dash-pots on the side of the cylinder above the exhaust valve, so as to shorten the dash-pot rods and reduce the inertia of the drop mechanism. The detaching gear is illustrated by Fig. 48, from which it will be evident that the grab hooks are towards the ends of the cylinder instead of on the inner side of the valve stems. This obviously puts the grap hooks and die blocks within easier reach for cleaning than the usual arrangement of these parts. Both the steam and exhaust valves of this engine are of the double-ported type of small diameter. The governor is of the high-speed type, a spring being substituted for the usual central weights.

Fig. 49 illustrates the governor and safety device. The governor balls *A A* are attached to the vertical arms of a pair of bell-cranks, and the other ends engage in the usual manner with a grooved collar on one end of a sleeve on the governor spindle. The other end of the sleeve carries another collar, which engages the inner end of the bell-crank lever *B*. The curved arm of this lever is connected to the knock-off cams of the valve gear by means of reach rods. If the governor belt breaks, the weight *N* will drop, and through the system of levers and links throw the bell-crank lever *B* so as to shift the safety blocks on the knock-off cams of the valve gear and prevent the valves from being opened by the grab hooks.

An auxiliary device is also provided to act in the case of racing. This consists of a small centrifugal governor of the shaft type mounted in the belt wheel of the main governor. The weight *W* of this auxiliary governor is provided with a lip, which, in the event of abnormal speed, will be thrown outward so as to engage with a small lip, *O*, on the end of the rocker arm shown. The other end of this rocker arm is connected to a latch which normally holds the throttle open. When the lip on the governor weight *W* engages the projection *O*, this latch is thrown, allowing the weight *M* to close the throttle.

The releasing gear used on the Watts-Campbell engines is illustrated by Fig. 50, in which *A* is the bell-crank lever, carrying the shaft *E*, one end of which is semi-circular, while to the other end is keyed the trip lever, having the roller *D* at its other end; this roller is held in contact with the knock-off cam *C* by the flat spring *S*. When the wrist-plate rod *W* moves in the direction of the arrow, the semi-circular end of the pin *E* engages with the steel die on the drop lever *B*, raising it, and opening the valve. When, however, the roller *D* reaches the raised part of the knock-off cam *C*, it is forced outward, turning the pin *E* so that it no longer engages with the die on the drop lever, thus releasing the lever, and consequently the valve. The dash-pot is of the hollow-plunger type described in connection with other engines. The minor differences may be readily noted by reference to the cross-section, Fig. 51.

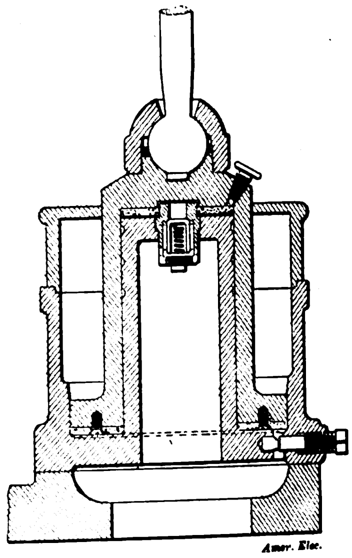


FIG. 51.

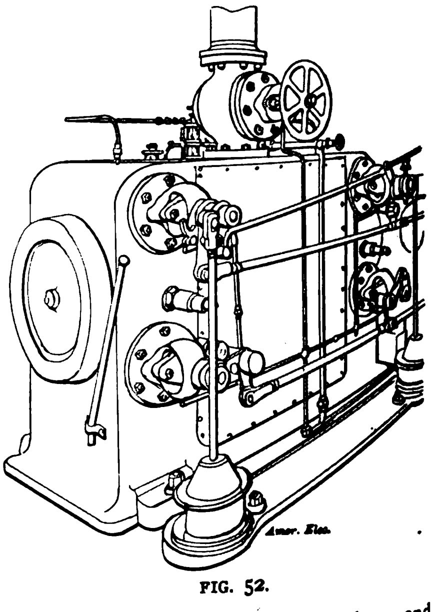


FIG. 52.

As in the case of the Harrisburg and Lane & Bodley engines, the absence of wrist-plates is a noticeable characteristic of the Rice & Sargent engine, illustrated by Fig. 52, and built by the Providence Engineering Works. The releasing gear used is shown in Fig. 53. The lever *L*, operated from the eccentric by the rod *A*, carries the block *C* keyed to one end of a short shaft, to the other end of which is keyed the trip lever *G*, which slides between the two rollers *E E* mounted on pins carried by the lever *H*, which is connected to the governor by a reach rod, *D*, and takes the place of the usual knock-off cam. In operation, as the eccentric rod *A* moves in the direction indicated, the block *C* engages the catch block *B*, mounted on the block *M*, which is keyed to the valve stem. When the point of release is reached, the trip lever *G*, owing to its peculiar form, is thrown outward, releasing the catch-block *B*, allowing the drop lever *M* to be drawn down by the action of the dash-pot.

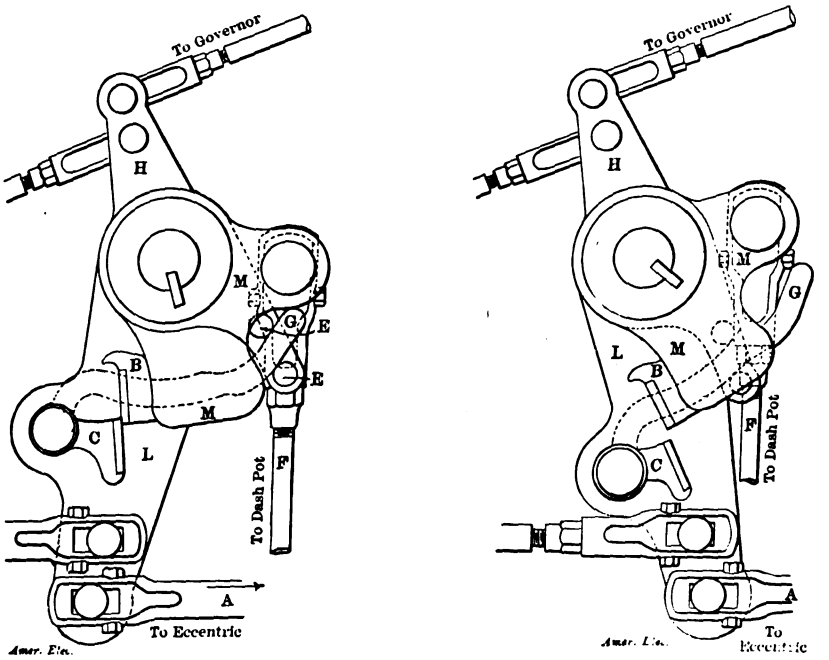


FIG. 53.

A type of detaching mechanism used by the Wm. A. Harris Steam Engine Company, which differs from the ordinary, is illustrated by Fig. 54. The bell-crank *E* carries a pawl *e* mounted on a pin. The drop lever *A* carries a short spindle at its lower extremity; to one end of this spindle is keyed the collar *B*, and to the other end the curved lever *D D*, the ends of which ride on the knock-off cam *C*. In the position shown, the pawl *e* has just engaged with the lever *B*, and the bell-crank lever *E* is being drawn in the direction of the arrow by the wrist-plate; the drop lever is carried along with it, opening the valve. The pawl *e* will remain engaged with *B* until the right-hand tip of the trip lever *D D* strikes the front of the cam and the other tip reaches *M*. At this point the catch-block *B* will be turned, thus releasing the drop lever and valve.

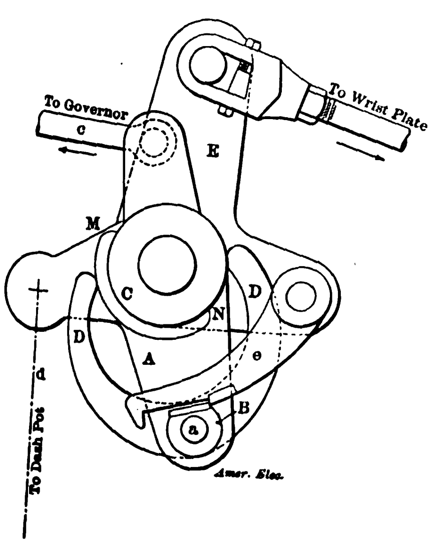


FIG. 54.

Fig. 55 shows the Brown valve-releasing mechanism, which is also used by the Wm. A. Harris Company, and Fig. 56 is a reference diagram. The lever *A A* carries the shaft *a*, to one end of which is keyed the grab hook *D*, and to the other end the trip lever, carrying the roller *E*, which slides in the groove of the knock-off cam *K*. The drop lever *B B* carries a movable die, *C*, suspended by a bolt, thus allowing it to rise as the hook *D* passes backward under it. As the lever *A* moves in the direction indicated, the valve is opened, and remains so until the roller *E* is thrown downward by the cam slot, disengaging the grab hook *D* and releasing the valve. The cam is so constructed that should the speed of the engine become abnormally low, or the governor belt break, the hook *D* would fail to engage with *C*, as is the case in all releasing gears.

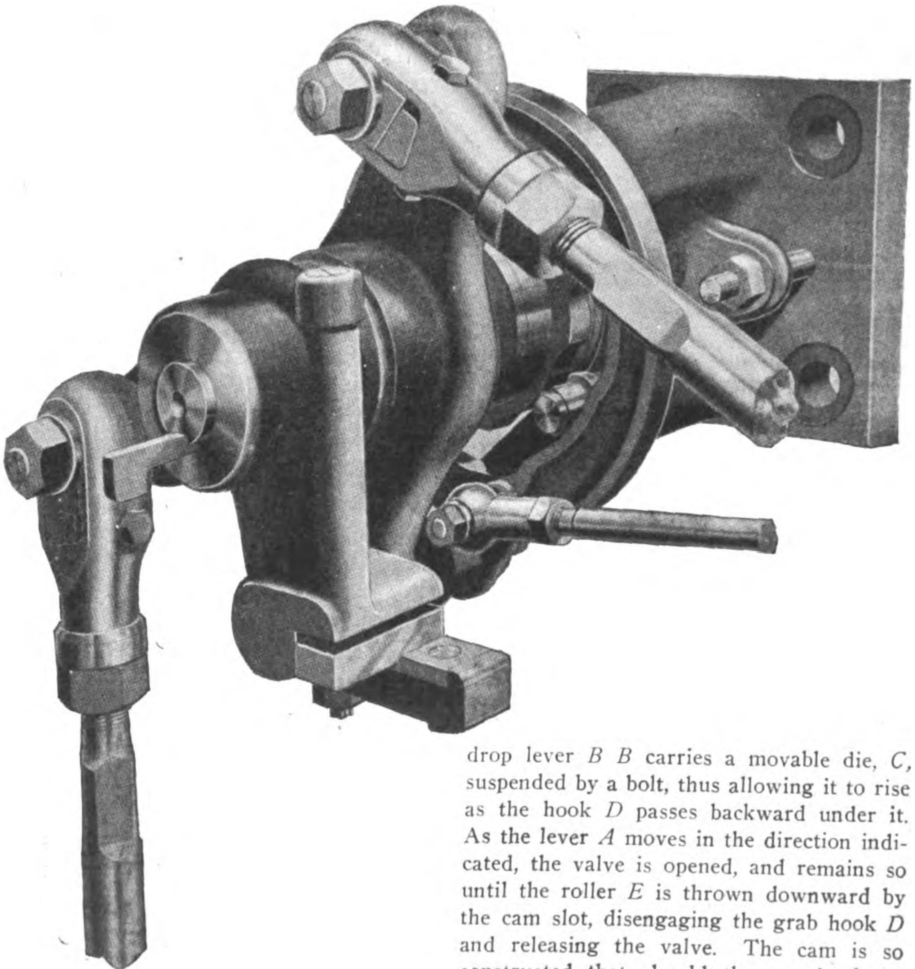


FIG. 55.

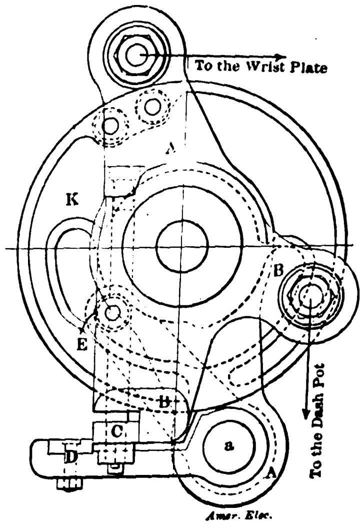


FIG. 56.

A quite different and extremely simple releasing gear is that used on the engines of the Rarig Engineering Company, Columbus, Ohio. A detail of the valve-gear is shown by Fig. 57. In this gear the grab hook and trip lever of the ordinary Corliss mechanism are replaced by the L-shaped hook *B*, pivoted on a pin carried by the bell-crank *A*, and having its free end held against the knock-off cam *C* by the spring *D*. In the position shown in the illustration, the cam has just thrown the catch-block on the hook *B* out of engagement with the drop lever *E*. This form of valve-gear, with double wrist-plates and two eccentrics, is used on the Class B engines of the company, while the standard Corliss gear is used on the Class A engines.

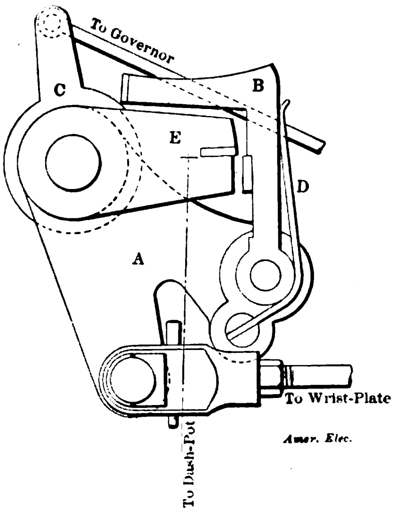


FIG. 57.

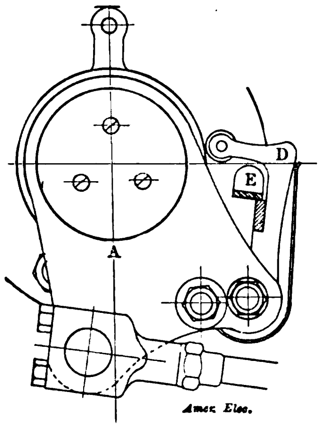


FIG. 58.

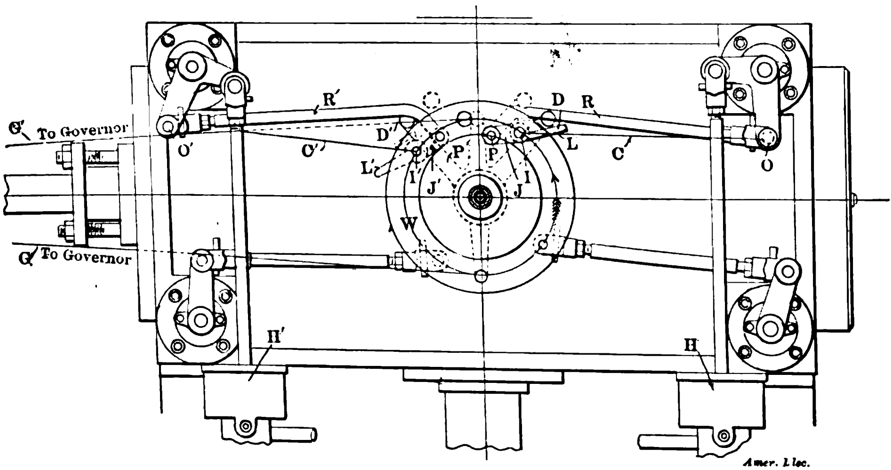


FIG. 59.—RELEASING BUT NON-DETACHING GEAR.

The Watertown Engine Company uses, besides the gear previously mentioned, the very simple form of releasing mechanism shown by Fig. 58, which is very similar to the one last described; the operation is exactly the same. A roller is used, however, on this gear to reduce the friction of the hook *D* sliding on the knock-off cam. The drop lever is keyed to the valve spindle within the valve bonnet, giving an outboard bearing for the valve stem and reducing the strain on it to a minimum. A single wrist-plate is used.

The Bates Corliss valve-gear, illustrated by Fig. 59, differs radically from all the others described in this article. The valve-releasing mechanism, while performing the functions of the regular Corliss gear in exactly the same manner, is not a detaching arrangement. The admission-valve stems carry simple bell-cranks, like those of the exhaust valves. The arms *D D* are pivoted on the same pin with the wrist plate, but independently, and are connected to the governor, their position defining the point of release. As the wrist-plate moves in the direction of the arrow, from its position in Fig. 59, the link *J'* will fold under the valve rod *R'* till the center of the pin *P'* falls below the line of pull *C'*. Then as the wrist-plate moves in the opposite direction, the valve rod *R'* will be pulled with it, opening the valve, until the end of the lever *L'* engages with the pin in the end of the arm *D'*, which, stopping the further movement of the lever, will unfold the knuckle formed by the arm *J'* and the valve rod *R'*, allowing the dash-pot to pull the rod *R'* to the left and close the valve. The form of mechanism, as is plain, is extremely simple and ingenious, and as no parts are actually disengaged, it is practically noiseless. It will also be noted that all die blocks, etc., have been dispensed with, and the number of wearing surfaces is unusually small.

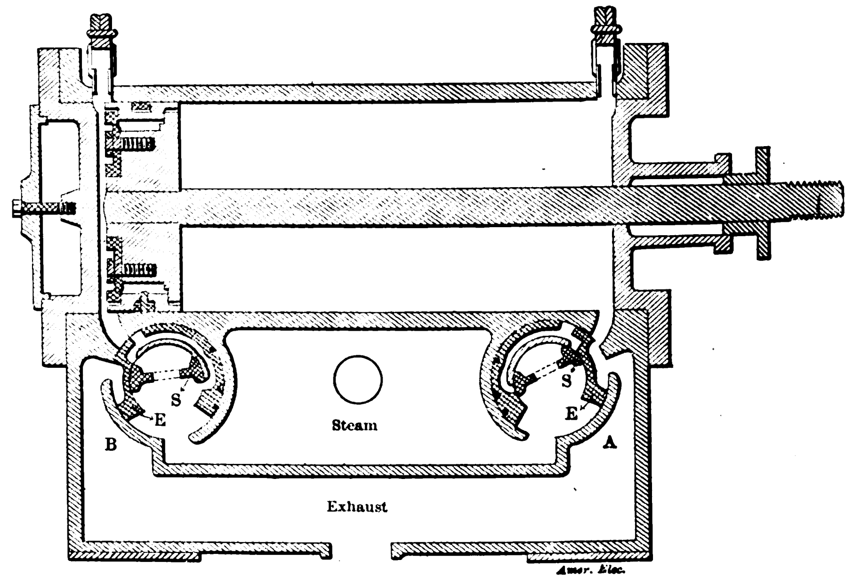


FIG. 61.—CONCENTRIC STEAM AND EXHAUST VALVES.

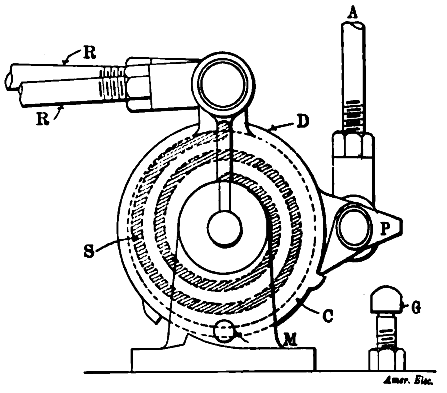


FIG. 60.

The safety device is shown in Fig. 60, in which *C* is a case containing a spring, *S*, one end of which is attached to the rim of the case and the other end to the hub of the disc *D*. The movement of the case *C* is normally controlled by the governor through the rod *A*, carrying the pawl *P*. Should the governor balls for any reason fall abnormally low, the pawl *P* would strike the adjustable screw *G*, causing the pawl to

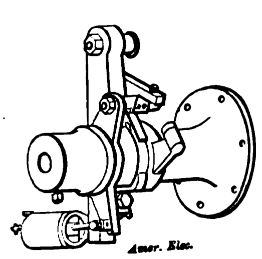


FIG. 62.

release the case *C*, which would be rotated by the spring inside so as to throw the trip levers to the position in which they prevent the valves from opening. As the engine is shut down the engineer pushes the pin *M* into a recess in the disc *D*, thus holding up the governor balls at such a height that the pawl *P* cannot come in contact with the adjustable screw *G*. The steam valves used on the Bates engines are of the central-opening balanced type, previously described, requiring but little power to operate them, and being subject to less wear than most other types.

The Twiss improved engine, built by N. W. Twiss, New Haven, Conn., though essentially of the Corliss class, differs from the ordinary in that the steam valve is enclosed in the exhaust valve, making practically only two valves, which, however, perform the functions of four perfectly. A cross-section through the cylinder and valves is presented in Fig. 61, where *E* is the exhaust valve and *I* the steam valve. The steam valve, of the double-ported balanced type, is held within the exhaust valve *E*, but is not set exactly in the center of the latter valve, so that it is held in position by steam pressure. The releasing mechanism is of the plain Corliss type described at length in the first part of this article. The chief differences are that the usual vacuum dash-pots are replaced by spring dash-pots—that is, the tension of springs is relied upon to close the valves, while the air cushioned in the dash-pot cylinder prevents the shock which would be inevitable were it not used. The cut-off valve is opened to steam by a stationary catch which engages with the valve lever. It is also evident from the construction that the dash-pot must move with the exhaust valve lever, as the exhaust and steam valves move together. Fig. 62 shows the gear for one pair of valves.

The Hartford Steam Turbine Installation.

BY P. C. PERCY.

The fact that a large steam turbine has been installed in the station of the Hartford Electric Light Company ceased to be news many months ago, and descriptions of the machine have been published far and wide. It is not the purpose of this article to recount well-worn facts, but merely to discuss some of the features which practical industrial tests have developed.

In the first place the turbine had to be installed under the unusual and tremendous disadvantage of never having had a full load test, for the reason that at that time the factory was not provided with steam-condensing facilities adequate for such a test. Consequently, all of the experimental work which is an inevitable accompaniment of any departure from established engineering lines had to be done at the Hartford station without any factory facilities except a crane. These facts explain the seemingly interminable delay in putting the turbine regularly to work.

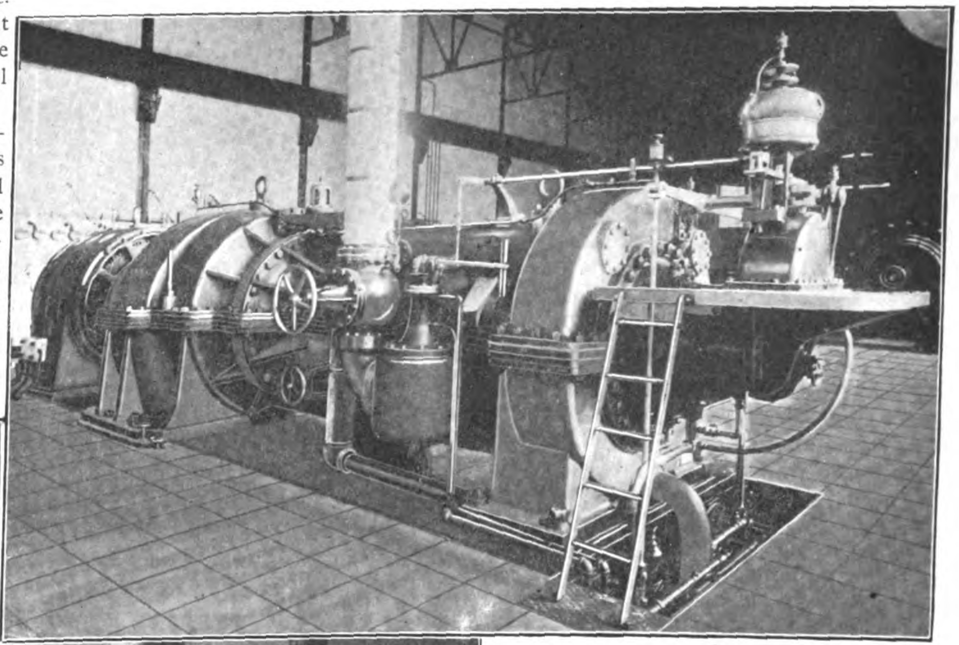


FIG. 2.—THE OTHER SIDE.

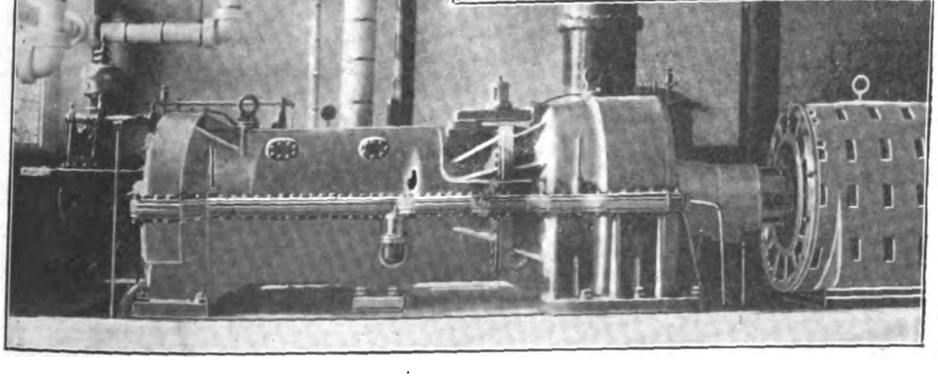


FIG. 1.—SIDE VIEW OF TURBINE AND ALTERNATOR.

When the turbine was first installed it developed that steam got in the oil and impaired its lubricating qualities so seriously as to render it inadvisable to attempt continuous operation. This was remedied by merely drilling a hole in such wise as to equalize the pressures in opposite parts of the affected bearing, and obviate the tendency of the steam to force its way in. "Drilling a hole" sounds simple, but dismantling a machine of this magnitude and getting the affected portion set for drilling is quite a healthy job. An inspection of Fig. 6 will convey some impression of the size of the vane wheel and counterbalance collars.

Upon making another start and running for a considerable length of time, it developed that there was an excessive axial thrust which must be corrected before reliability might be expected. Investigation showed that resetting the vanes so as to increase the endwise thrust exerted on them by the steam was required in order to reduce the preponderance of the pressure on the counterbalancing collars over the axial pressure on the vanes, and this has accordingly been done, with the result that there is now practically no end thrust, so that the thrust bearing is in a condition comparable to that of Othello.

At the next attempt at operation it was decided to make a test with superheated steam. Figs. 3, 4 and 5 are reproductions of curves taken during this test, which was made by Prof. W. L. Robb early this year, and the accompanying table gives most of the results of the test.

TEST DATA.

Duration of test, 4 hours and 12 minutes.

Average load	1998½ kw
Total output for the test	8394 kw.-hrs.
Water evaporated, total	160,424 lbs.
Water per kilowatt-hour	19.1 "
" " electrical h.p.-hour	14.25 "
" " pound of coal	11.12 "
Coal consumption, total	14,428 "
" " per kw.-hour	1.72 "
Average steam pressure	155. "
" vacuum at turbine	26.9 ins.
" " at condenser	27.3 "
" superheat	41.56° F.
" feed-water temperature	197.9° F.

The amount of water evaporated per

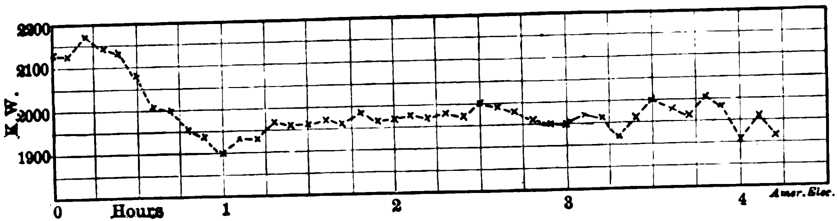


FIG. 3.—OUTPUT IN KILOWATTS DURING TEST.

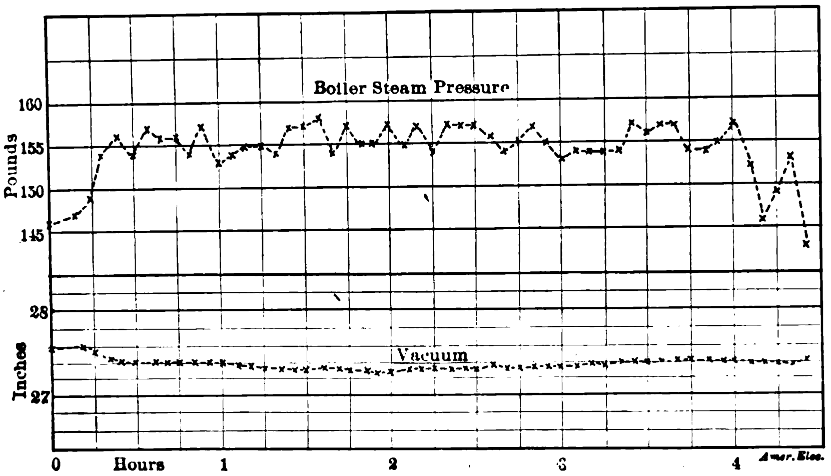


FIG. 4.—STEAM PRESSURE AND VACUUM CURVES.

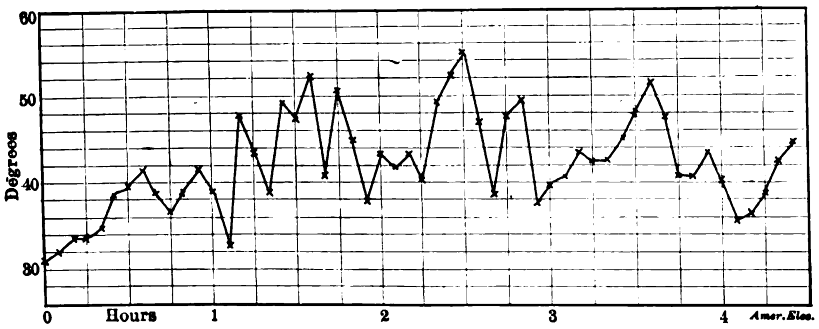


FIG. 5.—SUPERHEAT CURVE.

pound of coal, according to the above data, is so high as to encourage doubt as to the accuracy of the measurements, unless the coal was of strikingly high calorific value. Inquiry on this latter point elicited the naive statement that "the calorific value of the coal was not tested, but we bought the best coal we could find!" Of course, the ratio of coal to water consumption is purely a matter of boiler and furnace efficiency, and has no bearing on the performance of the turbine except that a knowledge of the character of the coal would furnish a rough guide as to the accuracy of the evaporation figures, which determine the turbine-generator economy. If the quantity of water actually evaporated was less than is stated, then the turbine economy was higher, of course.

According to Prof. Robb's unofficial estimate, the combined mechanical efficiency of the turbine and commercial efficiency of the alternator is 88 per cent. If this figure is authentic, the performance recorded in the test would be equivalent to a steam consumption of 12½ lbs. of steam per indicated horse-power-hour, which will be recognized as a very low figure in reciprocating engine practice. The corresponding coal consumption would be very nearly down to a pound, but, as pointed out above, the coal figures are worthless. With a better vacuum the performance would have been noticeably better, not merely on account of the greater temperature range or difference in back pressure in the ordinary sense, but for the reason that the velocity of the steam would have been increased, and the efficiency of the vanes at the large end of the wheel enhanced. A vacuum of over 27 ins. at the turbine appears to be quite feasible; in a short trial run made while the writer was present the vacuum ranged from a trifle below 27½ ins. to a point slightly higher, with a load of 1200 kilowatts.

The alternator is a 1500-kw. machine designed with a large overload margin, and the load of practically 2,000 kilowatts which was put on during the test gave rise to no sign of distress on the part of this member of the combination. The turbine, with its customary hard luck, was less fortunate. The use of superheat caused some expansion troubles, which, while relatively unimportant as to origin, were not negligible as to results, a quart or so of vanes being shelled off by the eccentric rotation of the vane-wheel, which had expanded to a very loose fit on the shaft. The elimination of this last source of trouble has just now been completed, and the trial run referred to above, made in the writer's presence within a few days before the preparation of this article, indicated no trouble of any sort. The load during this run varied from 1100 to 1400 kilowatts.

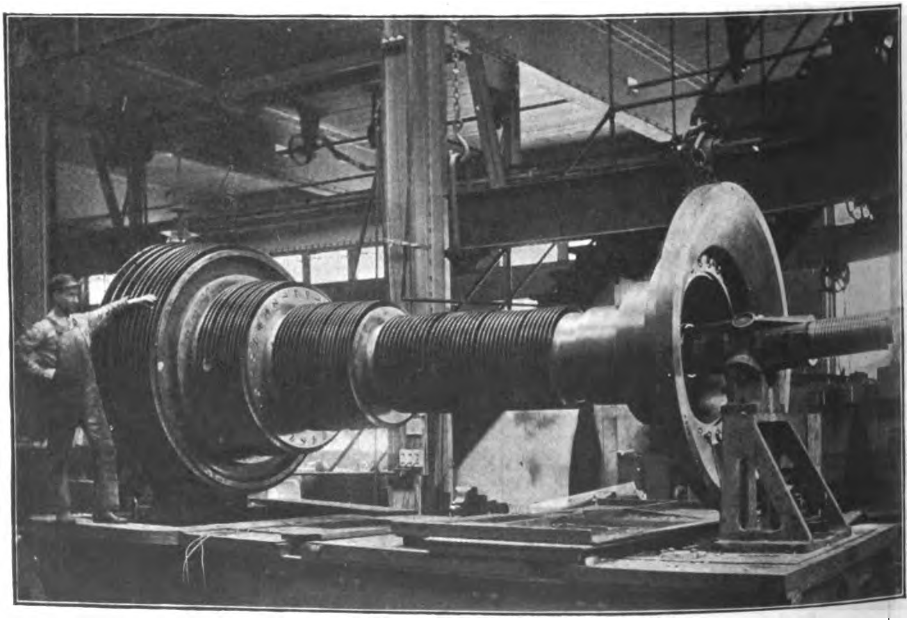
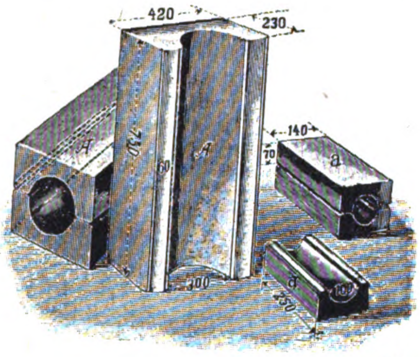


FIG. 6.—VANE WHEEL AND COUNTERBALANCE COLLARS.

Some interesting features were developed during the various trials of the outfit, aside from the incidental "snags" mentioned. As might readily have been predicted, the alternator may be brought into synchronism with the line and thrown in with much less difficulty than is the case with an alternator driven by a reciprocating engine. This, of course, is due to the absence of variation in angular speed, the rate of motion being absolutely uniform throughout each revolution. Another improvement is in the governing. Between no load and full load the speed remains practically unchanged at 1200 r.p.m. The superintendent of the Hartford plant informs the writer that no knowledge as to a "break-down" point analogous to that of an induction motor has been obtained, for the reason that no load that he has been able to put on the set has affected the speed appreciably. The pipe connecting the discharge of the counterbalancing-collar chamber with the main exhaust outlet has been considerably enlarged, and this appears to have increased the ability of the machine very much.

Abstracts from Foreign Contemporaries

Convenient Form of Electric Furnace.—Dr. L. Liebmann contributed to a recent issue of the *Zeitschrift für Elektrochemie* an illustrated description of a form of electric furnace which he has used for a number of years with satisfactory results for all kinds of electric furnace work. The furnace body is built up of two types of moulded blocks, shown by Fig. 1. The larger block, marked *A*, is made of the best fire clay, with a slight dip towards the center of the hollowed-out portion in order to retain any molten matter that may escape from the inner furnace. When the heating is carried on in these larger blocks, they are lined with magnesia to protect them from the direct effects of the arc or molten mass. The small blocks, *a*, are obtained by splitting with a chisel the ordinary stoneware ducts for enclosing electric cables. The solidity of these smaller blocks is sufficient to resist one heating in the furnace, and they are cheap enough to provide new ones for each heating. Fig. 2 shows various ways of arranging the carbons in these channeled blocks, and Fig. 3 shows the complete furnace arrangement, with the leads and the water resistance for varying the current used. The author states that he has used the apparatus as shown since 1894, with both direct and alternating currents, and obtained good results. The town supply of alternating current was at a potential of 120 volts, and it was necessary to reduce this for use in the furnace to 60 volts. This reduction was effected by the resistance shown by Fig. 3 without difficulty, and currents up to 250 amperes have been passed through it. The author has produced with this type of furnace calcium carbide, ferrosilicon, chromium, chrome-copper, molybdenum and phosphor-bronze alloys. The furnace permits the use of currents varying in intensity from 20 to 1000 amperes.



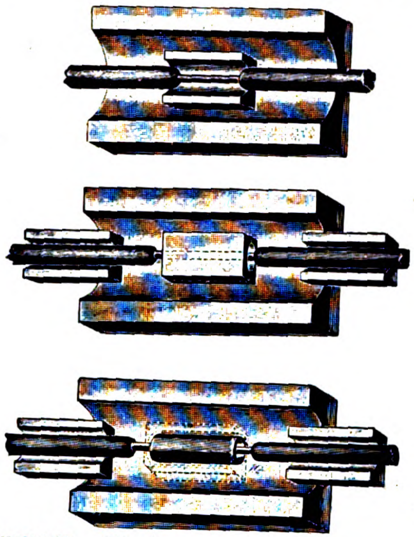


FIG. 1.—ELECTRIC FURNACE.—FIG. 2.

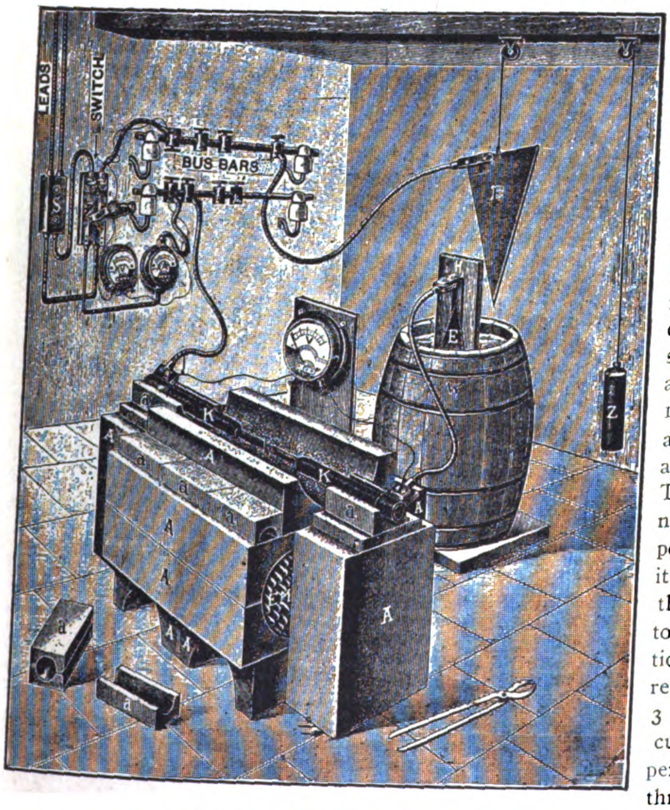


FIG. 3.—ELECTRIC FURNACE.

The Electrodeposition of Metals.—The *Zeitschrift für Elektrochemie* describes Darmstädter's patented improvements in the methods of obtaining bright metallic coatings in electroplating work. Insoluble materials, such as sawdust, sand, pumice in a finely divided state, or the salt composing the electrolyte (which in this case must be saturated), are added to the bath, and the contents kept in continuous motion by mechanical means. The effect of this finely divided insoluble matter is to loosen any bubbles of hydrogen clinging to the surface of the cathode, and also to act upon the latter as a burnisher. The production of bright, metallic deposits is said to be greatly aided by this process, and where the spongy nature of the deposit is chiefly due to the simultaneous separation of hydrogen at the cathode and to the adherence of small bubbles of this gas to the surface of the metal, the addition of finely divided insoluble materials to the electrolyte would appear to offer a simple means of overcoming the difficulty.

Engraving by Electrolysis.—The *Zeitschrift für Elektrochemie* describes in a recent issue an improved method for copying medallions and relief medals in metal by electrolytic means. The method, which is known as the Rieder process, is based upon the gradual electrolytic corrosion of a plane surface of steel by a plaster of Paris negative soaked with a solution of sal ammoniac and pressed gently against the steel surface, while the latter is made the positive electrode of the circuit. The surface of the steel is etched at the points where the plaster of Paris negative comes in contact with it; and as the steel is eaten away at these points the pattern is reproduced in reverse on the steel surface. The difficulty heretofore of carrying out this method on a practical scale has been due to the necessity of removing the plaster negatives at short intervals of time in order to clean away the deposit of carbon which formed on the surface of the steel; and the replacement of the negative in the exact original position was no easy task. This led to the design of the automatic apparatus shown by Fig. 4 for carrying out the Rieder process. *N* represents the plaster of Paris negative and *A* the steel plate upon which the relief is to be copied in reverse. The negative rests upon a sponge and is carried upon a supporting table *T*, which

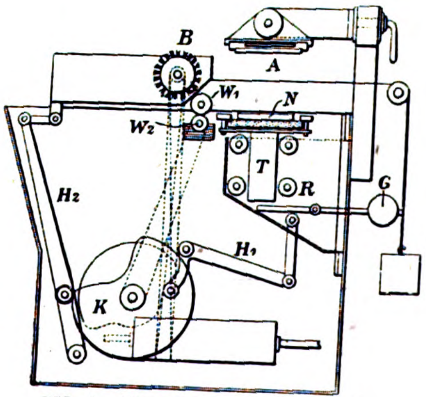


FIG. 4.—ELECTROLYTIC ENGRAVING.

has a vertical movement regulated by the motion of the cam wheel *K*, the lever *H* and the guiding roller *R*. The weighted lever *G* supplements this upward motion of the table, and gives sufficient pressure to preserve contact between the two surfaces as the electrolytic action on the steel progresses. The sal ammoniac solution is fed to the plaster negative by two rollers, W_1 and W_2, the former being pushed forward by the lever H_2 over the surface of the plaster when the table *T* is at its lowest point. The same horizontal motion of the lever H_2 carries forward the brush roller *B*, by which the surface of the steel plate *A* is cleaned and prepared for a fresh contact with the negative. The roller W_2 dips in a trough carrying the sal ammoniac. The apparatus is automatic in its action, and the electrolytic etching of the steel plate can be carried to any desired depth without personal attention when once the plates have been fixed in position, and the current connections made.

Enclosed Arc Lamp.—The London *Electrician* describes the latest addition to the already long list of enclosed arc lamps, which, however, possesses some novel features to warrant its introduction. Fig. 5 is a sectional view of the lamp, from which it will be seen that the number of moving parts is not very large. The upper carbon holder, *A*, is a drilled casting, slotted to insure sufficient spring to grip the carbon, the holder sliding in a tube, from which the current is collected by a laminated contact above the holder. Copper gauze washers mounted on the holder shank form this contact, and side pressure on the tube is obtained by the action of the clutch when the lamp is burning. The clutch is shown at *B*, the carbon being gripped by the ball-shaped fitting, which exactly fits the tube; so that alignment is guaranteed, and the carbon also guided and regulated in its descent from the main coil fixed to the top plate of the lamp. The globe *C* is securely clamped to an extension of the top tube, the joint being made by asbestos insertions. A hole allows for cleaning and trimming, there being no occasion to remove the globe. The lower carbon holder, *D*, is a substantial fitting, comprising a base plate for the lower carbon and a top plate connected with the holder by two rods. This upper plate is screwed to fasten to the main tube at the top, this operation sealing the handhole and making connection to the bottom carbon. The extension of the main tube is in the negative circuit, the positive side, in direct-current lamps, being connected to the lamp frame. The action of the lamp is very simple; the upper carbon is gripped and raised by the main coil, which gradually allows the clutch to loosen its hold as the arc lengthens, thus maintaining the distance between the carbons as long as the current passes. The plunger in the solenoid is fitted to form a dash-pot for steadying the movements of the working parts. An enamelled reflector concentrates the light beneath the lamp, and trimming can be easily performed without fear of damage to any of the parts. The average carbon life is said to be 60 hours, and at the end of the first period after complete trimming the top carbon only needs renewal, as the lower carbon is sufficiently long to act as a negative for the succeeding period. The lamps are supplied for parallel working on 110-120-volt circuits, or two in series when the pressure is double this, and may be used on either alternating or direct-current mains.

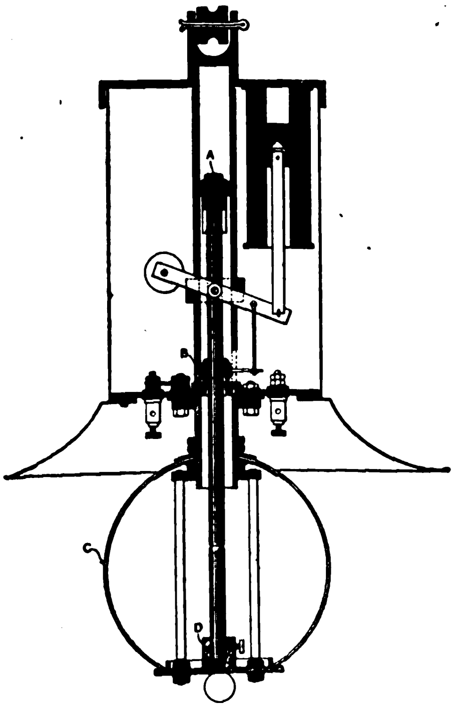


FIG. 5.—ENCLOSED ARC LAMP.

Zero Method of Magnetic Measurements.—Rudolf Goldsmidt contributed to a recent number of the *Elektrotechnische Zeitschrift* an article on the zero method of magnetic measurements. The number of lines of force N_1 and N_2 generated by two coils, S_1 and S_2, Fig. 6, can be compared with one another by winding N_1 with S_1 auxiliary turns and N_2 with S_2 turns. These auxiliary windings are so connected in series with a direct-current millivoltmeter that when N_1 and N_2 are reduced to practically zero the e.m.fs. introduced in them are in opposite directions. If the number of turns s_1 and s_2 are varied in number, so that there is no deflection on interrupting the exciting current, the following equation holds: $N_1 \div N_2 = s_1 \div s_2$. The direction of the swing of the needle reverses as soon as the number of windings is more or less than that required for a balance. When measuring the magnetic leakage on a direct-current machine few turns may be employed. The connections are shown in Fig. 7. A number of turns are wound about the magnet coil, and one more than that number on the armature. The windings are then connected in opposition. The wires may be thin and insulated with cotton, so that the insulation may be easily pierced, or may even be quite bare. $N_2 \div N_1$ gives the leakage coefficient. In a similar manner it may be ascertained whether an armature is properly centered. Auxiliary windings are pushed on between two poles of opposite polarity, the exciting current interrupted, and the number of lines of force which emanate from the poles are compared. Where the armature windings are connected simply in parallel, and where good centering is necessary, the armature may be shifted during the measurement, the position of the armature being adjusted so that the millivoltmeter gives no deflection when the exciting current is interrupted. In the determination of the back ampere turns of a direct-current armature for different positions of the brushes, a number of turns are wound around one pole and connected to the millivoltmeter. The armature is then excited, and the back ampere-turns compensated for by the field excitation. When there is no deflection on the instrument of the interruption of the current, the compensation is correct. A simple method of determining the ratio of transformation in transformers is also given. The primary and secondary coils S_1 and S_2, Fig. 8, of one limb of the transformer are connected in parallel and joined up to a small battery,

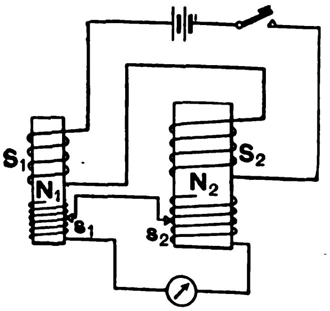


FIG. 6.

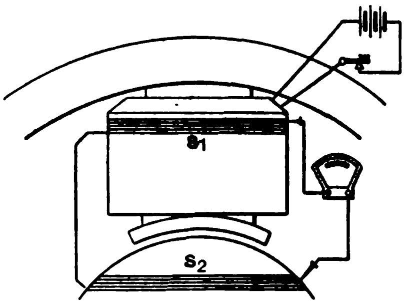


FIG. 7.—LEAKAGE TEST.

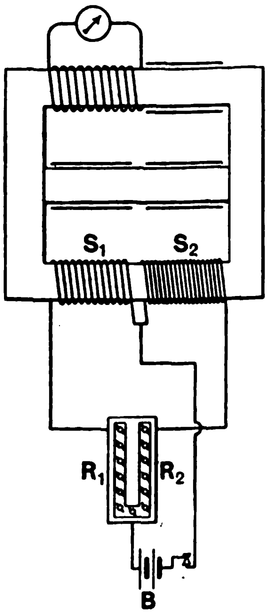


FIG. 8.—TRANSFORMER TEST.

B, through resistances R_1 and R_2. The number of lines of force generated by S_1 and S_2 pass through the same path, so that they may be replaced by a single winding, and the secondary winding of the second limb of the transformer may be made to answer for that purpose. The resistances R_1 and R_2 are adjusted until there is no deflection upon breaking the current. Then, neglecting the resistance of the transformer winding, the ratio of transformation is $R_2 \div R_1$. It is not exactly clear, however, why it should become necessary to determine transformer ratios experimentally.

Eavesdropping Indicator for Telephones.—According to the *Elektrotechnische Zeitschrift*, a simple and interesting apparatus has been tried experimentally on the lines of the government telephone exchange at Stockholm, Sweden, for the last year, which indicates to the subscriber whether or not the central station operator is listening to the conversation, Bridged across the subscriber's line and connected to it by a single pole switch is a current detector, the middle point of which is earthed. The central point of the operator's receiver is also earthed through the busy test battery in the ordinary manner. When the operator switches in her telephone through the listening key, a current is sent over both lines in parallel through the subscriber's indicator and to earth, and the telephone subscriber knows that the operator is on the line. The indicator itself has a pair of astatic needles, upon the axis of which is placed a light disc with black, white and red crosses painted upon it. The disc moves behind a shutter so that red or white shows that the operator is listening. When the communication is through two exchanges, the connections can be so arranged that a white cross indicates that the operator at one exchange is listening, and a red cross that the operator at the other end is in circuit. The apparatus is said not only to work well, but to be quite popular with the subscribers.

Device for Cleaning Commutators.—The *Elektrotechnische Zeitschrift* describes a new device, brought out by the firm of Stachow & Kuppers, of Berlin, for the purpose of cleaning commutators. The device is made in fifty sizes, one of which is shown by Fig. 9, herewith. It consists of a wooden base, having affixed at one end a tightening device, and on the other end is a recess containing a dust box for collecting the copper dust. The emery cloth rests on an elastic cushion, and can be easily removed and renewed by releasing it from the tightening device. The dust box is provided with a strip of rubber, which impinges on the commutator so as to rub off the dust which clings to it, and it is further enforced by a brush placed directly in back of it. The rubber is housed in a wooden batten, somewhat similar to a weather strip. A long pivoted handle is provided, so that the device may be fulcrumed at some convenient point in order to get sufficient pressure to bear on the commutator surface.

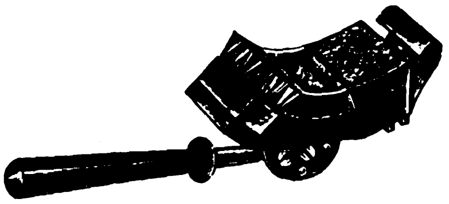


FIG. 9.—COMMUTATOR CLEANER.

Some Recent Electrical Patents

Trolley Car Current Economizer.—Fig. 1 illustrates an apparatus which has been devised by Emil D. W. Reichel for the somewhat unusual purpose of reducing the amount of power delivered to an electrically-propelled car during those periods when the car motors are taking the greatest amount of power from the line. Mr. Reichel provides a cut-out, *c*, actuated, by a solenoid, *i*, which is connected in series with the car motor, *g*. The function of this cut-out is to open the circuit through the car heaters, *q q*, when the current through the car motor, *g*, rises about the predetermined amount. For example, when the car is started up, the rush of current through the motors is usually heavier than at any other time, and under these conditions the solenoid, *i*, would open the circuit through the car heaters and reduce the total amount of power delivered to the car by the amount required for the heaters. The dotted lines show the cut-out lever in its open-circuit position. The cut-out would, of course, be adjusted so that when the car is running under normal conditions, and the motors are taking the average amount of current, the solenoid would release its levers and restore the connection between the heaters and the supply circuit. Patent No. 692,348.

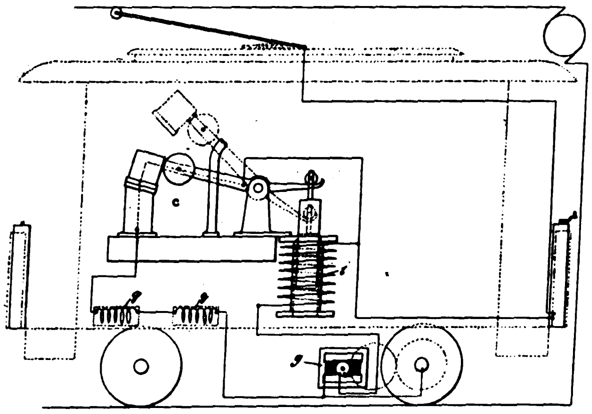


FIG. 1.—TROLLEY CAR CURRENT ECONOMIZER.

Copper Pole Bridge.—It has become common practice to put bridges of conducting material across from tip to tip of neighboring pole-pieces on rotary converters and alternators for the purpose of checking any tendency to hunting, but where solid pieces of metal are used there is a wasteful production of eddy currents in the metal of the pole bridges, due to the sweeping across of tufts of magnetic lines of force from the armature teeth. The eddy currents referred to are not the occasional currents that are set up when the machine hunts, but are produced at all times, whether there is any hunting or not. With a view to eliminating this waste of energy, Ernst J. Berg, of the General Electric Company, has devised and patented the form of pole bridge shown in the accompanying engraving. The improvement consists simply of slotting the pole bridge, the slots being of the same width and pitch as the slots in the armature core. The result of this is that the eddy currents produced in the strips are very much reduced by reason of the greater resistance of the path through which they have to flow. The strips being spaced coincidentally with the teeth of the armature, the e.m.fs. induced in the adjacent strips are so nearly equal that the tendency for a flow of current up one strip and down the one next to it is infinitesimal. Patent No. 697,783.

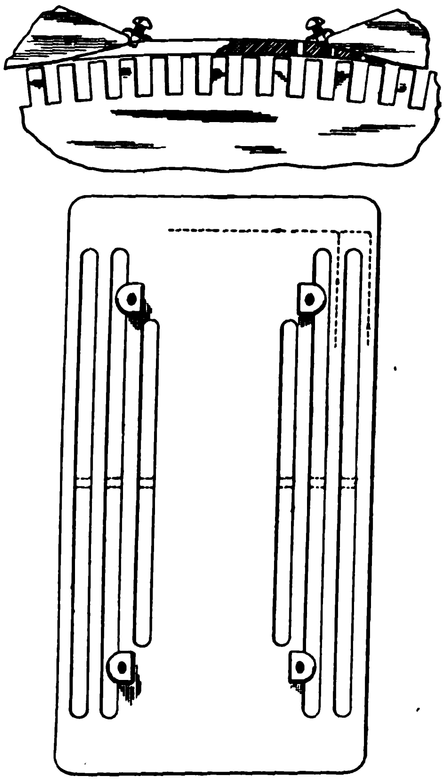


FIG. 2.—POLE BRIDGE.

Multi-Voltage System.—The advantages of a multi-voltage system for the operation of electric motors have become thoroughly well known, and several of these systems have been devised and patented. One of the more recent of these is illustrated by the accompanying diagram, and has been patented by Alexander D. Lunt, of the General Electric Company. In the diagram the main direct-current generator is indicated by the figure *1*. A rotary converter, *9*, takes current from the mains and transforms it to two-phase alternating current, which is delivered to the sectional auto-transformers 16 and 17; the e.m.f. of these auto-transformers is adjustable by means of the switch *19*, which cuts in or out similar sections of the two windings simultaneously. These variable e.m.fs. are delivered to another rotary converter, *25*, which changes them into direct current again. It is thus possible to adjust the e.m.f. between the distributing wires *6* and *8* through a wide range. The e.m.f. between the neutral wire *7* and each of the other wires, *4* and *5*, remains unchanged, but it will be obvious that the e.m.f. between *6* and *7* and *8* and *7* may be adjusted widely by means of the switch *19*. The range of adjustment is said to be from a point at which the distributing wires *6* and *8* are almost at the same potential as the neutral wire *7*, up to a point where the difference of potential between these two is equal to or even greater than the differenc of potential between the main wires *4* and *5*. It is thus possible to obtain a large number of intermediate voltages, and it will be evident that such a system may be used for starting up all the motors of an entire factory simultaneously, by connecting the full-voltage machines between the neutral wire and each of these, starting with the difference of potential between *6* and *8* at the lowest point and gradually increasing it until it is equal to the difference of potential of the main wires *4* and *5*. Patent No. 697,733.

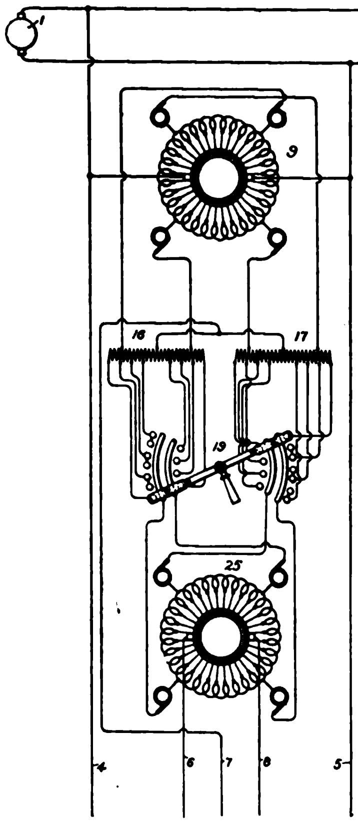


FIG. 3.—MULTI-VOLTAGE SYSTEM.

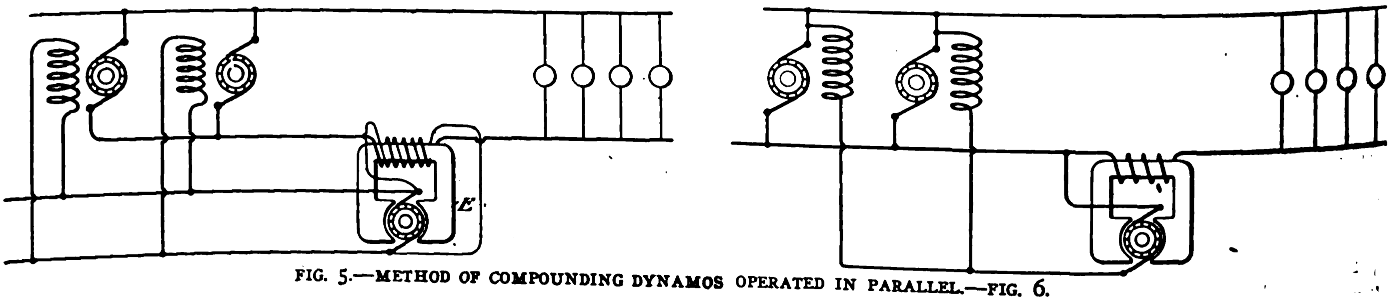
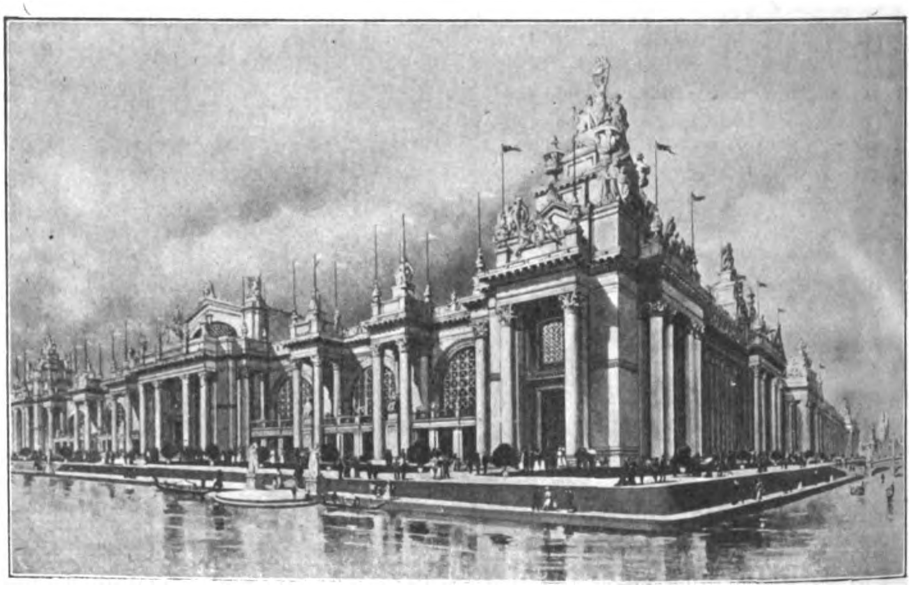


FIG. 5.—METHOD OF COMPOUNDING DYNAMOS OPERATED IN PARALLEL.—FIG. 6.

Compounding Generators in Batteries.—It is a well-recognized fact that the operation of compound-wound machines in multiple is not usually accomplished satisfactorily unless the machines happen to be of exactly the same type and external characteristic, for the reason that it is impossible to adjust the compounding of any one machine independently of the others. A system of compounding which obviates this objection has been devised and patented by Frank G. Baum, of Stanford University, and is illustrated diagrammatically herewith. Mr. Baum proposes to use an exciter for the generators which has a series field winding connected in the main circuit, so that the field strength of the exciter will vary directly with the load supplied by the generators. The exciter delivers current to the field windings of the generators in parallel, exactly as is done in the case of alternating-current generators, and it is obviously possible by this arrangement to obtain any desired degree of compounding on all of the generators, and also to vary the compounding of the machines individually in order to compensate for varying characteristics. The arrangement described is shown in Fig. 5, where the exciter is provided with a self-exciting shunt field winding compounded by the winding in series with the work circuit. Fig. 6 shows a modification of this, in which the windings of the generators are connected in parallel with each other and in series with the exciter armature across the main line. In this case the generators would, of course, be self-exciting, and the exciter dynamo would serve merely as a booster to increase the field excitation of the generators upon an increase in load. By providing adjustable resistance in series with the generator windings the degree of compounding may be adjusted for individual machines. Patent No. 698,245.

ELECTRICITY BUILDING FOR THE ST. LOUIS EXPOSITION.

The plans for the various structures to be erected on the grounds of the coming St. Louis Exposition are being rapidly consummated, and contracts have been already awarded for the erection of a number of the buildings. Of these Electricity Building is now in process of construction. It will be located on the main central avenue, forming one of the leading elements of the main exposition picture, and will have a frontage of 650 ft. toward the north and 525 ft. toward the east, facing the main lagoon.



ELECTRICITY BUILDING; ST. LOUIS EXPOSITION.

The design is a bold treatment of the Corinthian order. The columns are carried well down toward the ground, to give height to the facades, which will be well accentuated by elevated pediments and tower effects over the main entrances and at the corners. Over the accentuated places, as well as over the twin columns, which form a pleasing variation of the treatment of the facades, opportunity for ample sculptural decoration is supplied.

The fenestration is bold and appropriate, giving ample light and substantial wall treatment. On two sides of the building are to be loggias, which will add pleasing effects of light and shadow. There will be numerous openings on the facades, such as exhibitors always seek in selecting their exhibiting space. The plan of the building is simple and well treated, with a view of supplying as much exhibit space as is possible with the 292,000 sq. ft. of floor space. An extensive balcony will extend around the four sides of the building, supplying 100,000 sq. ft. of additional space.

A large traveling crane, to be used in the installation of the heavy electrical machinery to be shown in the building, will run on tracks in the western bay. The doors of the building will be 11 by 18 ft. The building will have 176 trusses, the largest span being 82 ft. in length, and 185 tons of iron and steel will be used in its construction.

The specifications for the building provide for a temporary stairway leading up to the roof, to be put up of rough lumber, and to be taken out before the completion of the building. The object of this is to make the building a show place during construction, so that visitors may ascend to the roof without the necessity of climbing ladders and crawling through scuttle holes.

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NOTES.

Northwestern Electrical Association.—The summer convention of the Northwestern Electrical Association will be held at Waupaca, Wis., beginning Wednesday, June 18. A meeting of the Wisconsin Independent Telephone Association will be held jointly.

Another Sunbeam.—This time it is the Baltimore *Sun* which undertakes to shed illumination on technical subjects. Concerning a Maryland plant on the Patapsco River, this paper said recently: "The electrical apparatus is of modern type, and of multiple horse-power. The streets have been re-wired, and hereafter the lights will be serial."

Long Distance Power Transmission in Italy.—An order was placed recently for the machinery for a 13,000-h.p. plant, the station of which is to be located on the Cellina River, in northern Italy. Three-phase currents will be generated at a comparatively low potential, and raised by step-up transformers to 36,000 volts for transmission to Venice, Udine, Perdenone and other cities. The longest distance to which power will be transmitted is 56 miles.

Scale in Gas Engine Water Jackets.—A simple method of removing scale in gas engine water-jackets, due to the use of "hard" cooling water, according to a statement made by Mr. C. W. Andrews at a recent meeting of the Ohio Gas Light Association, consists of filling the jacket with commercial muriatic acid and allowing it to stand until the removal of the scale, with the attendant evolution of carbonic acid gas, is completed. A single application has been found generally sufficient if the scale is light.

The St. Louis Exposition.—It has been definitely decided that it is not practicable to hold the Louisiana Purchase Exposition at St. Louis next year, and the exposition has therefore been deferred until 1904. Under ordinary business conditions it is said that the buildings and grounds for the exposition could have been prepared in time to hold it next year, but the tremendous business activity and congestion everywhere render impossible the rush work which would have been necessary in order to accomplish this.

A 25,000-Volt Direct-Current Dynamo.—The Swiss manufacturing concern which builds Thury dynamo-electric machines and other apparatus recently constructed a 25,000-volt, 25-kw., direct-current dynamo to run at a speed of 600 r.p.m. The machine was provided with a revolving field magnet, which was laminated, and the armature contained only forty-eight coils. The commutator was, of course, stationary, and was provided with ninety-six segments, with air insulation, and an air blast was employed to blow out the sparks at the brushes, the difference of potential between commutator segments being a trifle over 520 volts. The brushes were arranged to revolve inside the commutator in order, presumably, to utilize the centrifugal force to maintain contact between the brushes and the commutator.

Recent Steam Practice in England—An extensive electric lighting plant recently built in Hammersmith, London, contains several features of interest, among which may be mentioned a cooling pond designed to take care of the condensing water, and storage tanks for boiler feed water. The cooling pond is 100 ft. long, 60 ft. wide and 7 ft. deep, and is intended to take care of the condensing water for engines aggregating 2500 horse-power. The bottom of the tank is of clay, and it is lined with cement concrete and bitumen sheeting. There are 84 jet fountains, to which the water is pumped under a head of 100 ft. Rainwater from the roof of the building is delivered to the pond. The storage tanks are cast-iron structures, 112 ft. long, 16 ft. wide and 6 ft. deep, and are located above the boilers. The boiler plant comprises five Babcock & Wilcox boilers, having a rated evaporation capacity of 14,000 lbs. of water per hour each at 200 lbs. pressure.

Summer School for Artisans.—The University of Wisconsin, Madison, Wis., announces that arrangements have been made for a summer school this year for apprentices and artisans, to be conducted under the auspices of the College of Engineering of the university, the intention being to give stationary engineers, station superintendents, machinists and others an opportunity for educational training during that part of the year when such persons can best spare the time for study. Any person over 16 years of age speaking the English language and having a fair knowledge of arithmetic will be admitted to the summer course. The tuition fee for the term is $15, with an additional laboratory fee of five cents an hour for all time spent in practical work. The courses of instruction are in the Use of Formulas, Mechanical Drawing, Steam Engineering, Applied Electricity, Transmission of Power, Strength of Materials and Shop Work in Carpentry, Forging and Machine Tools.

A Transformer Complication?—There were issued on March 18 to Profs. Elihu Thomson and E. J. Houston, and on April 22 to Prof. Thomson alone, two transformer patents, which appear to be so phenomenally broad as to cover all commercial applications of this very useful apparatus. Applications for the patents were filed February 19, 1887, and November 2, 1885, respectively. The latter patent, issued to Prof. Thomson, covers a system of electrical distribution consisting of transformers connected in multiple to a primary supply circuit and having secondary windings delivering current to translating devices. This, of course, covers practically all commercial applications of the transformer, and it would appear that some extremely vigorous litigation will be precipitated as a result of the issuance of the patent. The patent of March 18, to Profs. Thomson and Houston jointly, while not quite so broad as the one issued to Prof. Thomson alone, is sufficiently broad to cover all ordinary transformer practice, only step-up transformers being outside the scope of the patent.

Electric Elevators.—At a recent meeting of the American Institute of Electrical Engineers Prof. George F. Sever read an interesting paper on "The Power Consumption of Electric Elevators," in which the results of tests made on installations in New York City were presented. The paper showed that there are approximately 3000 elevators in New York operated by direct-current motors and 300 driven by alternating-current motors, and the object of the paper was to draw a comparison between the two forms of motor for this class of service. Twenty tests were made, five of which were on direct-current machines and fifteen on alternating-current machines. One conclusion drawn by Prof. Sever was that, with power at 10 cents per horse-power-hour, it is more economical to use direct-current motors for elevator work where both direct and alternating currents are available. Other conclusions expressed were that if the controlling apparatus of the alternating-current motor is more simple, and the absence of commutator and brushes can be considered as an advantage, the extra expense for power required by an alternating-current machine might be offset by the decrease in repairs and attendance; apart from these considerations the direct-current motor has every advantage. The conclusions drawn in the last sentence have been well-known facts for two or three years past.

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Corliss Valve Gear.

It is a very remarkable fact that the releasing gear devised by Sickels in 1841 and adapted to rocking valves by Corliss about ten years later is in wide use to-day, essentially unchanged from Corliss' arrangement of it. This, of course, is strong evidence of the high merit of this form of gear, but it seems odd, in view of all the progress in mechanics, that no valve-gear should have been devised which would render the grab hook and trip release obsolete by this time. The positively-driven valve with bell-crank gear so disposed as to afford maximum speed at the moment of first opening, has come into considerable favor, but it is a noteworthy fact that the releasing gear still holds sway where moderate speeds—below 120 r.p.m. or thereabouts—are in vogue, as Mr. Schmidt's article in this number plainly indicates.

The continued popularity of the type of gear under discussion is undoubtedly due to its utter simplicity and efficiency. The detaching and almost instantaneous closing of the valve gives a sharp corner at the junction of the steam and expansion lines of the indicator diagram, so that, to quote an old steam engineer, "you know just where you *are* cutting off" (if this is of any practical value); and while the gear in concrete form appears complex to a slide-valve user, it is extremely simple in principle, and when independence between the admission and exhaust valves is provided it lends itself to almost any degree of manipulation. The requirement of two eccentrics and gears for long-range cut-off, however, is obviously a mechanical disadvantage, and it must be admitted that in comparison with a single-valve engine the long-range four-valve releasing gear is a maze of complication structurally. The considerations which prompt its use are, of course, well founded, and are too well understood to require comment here.

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Economical Operation of Small Stations.

Electric light plants in towns of 2000 to 5000 inhabitants are not, as a rule, considered shining examples of prosperity nor excitingly attractive financial investments, although those of them that are blessed with sagacious business management and competent engineering talent undoubtedly pay well. As has been pointed out in these columns before, however, this number is in a conspicuously small minority. In many cases the lack of prosperity is due to unfortunate circumstances, which render skilled engineers and capable business managers unavailable, but probably more often the trouble is either that the owners of the plant are not awake to the possibilities of the business, and let things drift along in any fashion, or that they are not sufficiently progressive to spend any more money without a cast-iron guarantee of results.

It seems incomprehensible that men of ordinary business judgment will allow a plant to lay idle during the greater part of each twenty-four hours, when it might be furnishing power for the various industries of the town and carrying an incidental lighting load which, though it would not of itself justify day operation, would help materially to swell the income. It is a self-evident proposition, generally speaking, that a given amount of power can be supplied more cheaply from a central station than from a number of insignificant little steam engines giving indicator diagrams resembling the outline of a soap box. This has been pointed out and demonstrated so often that it has reached the most hackneyed state of triteness. Why then permit a possible day-load to remain unclaimed and reduce the station's percentage of activity to about 40 per cent of the possible performance?

Much depends, of course, upon the local industrial conditions, but it is a very poor sort of town that has not a number of small industries sufficient to make an encouraging aggregate day load in comparison with the normal night load. And if the waterworks pumping plant can be obtained as a motor load, it will be very rarely the case that day operation is not feasible. In almost every small town it is entirely practicable to restrict the periods of pumping to the small-load hours of the lighting station, as is done at the Whitehall plant described in our leading article. All that is necessary to this end is the provision of a pumping outfit of, say, 50 per cent greater capacity than would be required for continuous pumping, and a correspondingly large reservoir or stand-pipe. As these would be dictated by common engineering foresight anyway, the matter of waterworks operation reduces to the judicious choice of apparatus and some slight modifications of it.

The plant at Whitehall is a striking object lesson in this particular. Instead of being discouraged by the lack of standardized electric pumping apparatus that would fit the peculiar requirements of the case, the persons interested proceeded to modify market machinery so as to overcome the difficulties presented by the project under consideration. The result is that this plant embodies practical solutions of the chief problems that will develop in the large majority of plants in connection with heavy-duty pumping by means of alternating-current motors. A modification of the controlling rig used here in order to make it applicable to a polyphase motor is perfectly obvious, requiring not even ordinary ingenuity; and only a fair working knowledge of mechanics and motor practice is required to adapt the Whitehall arrangement to a direct-current machine.

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Elevator Motor Tests.

In a paper on this subject, read before the American Institute of Electrical Engineers recently, there were presented some remarkable records of alternating-current elevator motor performance. The worst of the lot was a 200-volt motor that took 150 amperes for starting a load that required only 6 amperes to keep it going, and the records ranged from that up to one of 70 amperes starting current and 29 amperes for running. The ridiculous showing of a starting current thirty times the running current is not worth serious consideration, and it is obvious that this does not properly represent the capabilities of the induction motor in this class of work. They are poor enough at best, but there is no excuse for such a performance as this except sheer engineering recklessness in the selection of the type of motor, or, rather, the method of control. The motor in question had a squirrel-cage rotor, without even a starting resistance in the primary circuit; so did all the others save two.

The tests on all of the squirrel-cage machines showed starting power factors from twice to three times the running power factors, which indicate infallibly one of two things: either the machines were absurdly underloaded or the test measurements were inaccurate. The squirrel-cage motor has not yet been built that will start its full load, or anything near it, with a power factor, without the aid of condensers. It is probable that extremely light loads account for the power factor readings, and it does not appear what object there was in making the tests under such conditions. So far as engineering knowledge is concerned, fourteen out of the fifteen tests represented a profligate expenditure of time, as the facts elicited have been generally recognized for several years.

The one alternating-current motor that established any claim to respectful consideration was equipped with a four-step starting resistance in the rotor circuit, which has for some time been recognized as the only method of satisfactory operation under elevator conditions. This machine, rated at 15 horse-power, started a load of 1200 pounds (overweighted 500 pounds) with 70 amperes per phase or a true power of 25.2 kilowatts and a power factor of 90 per cent.; the running current was 29 amperes per phase with a power factor of 41.4 per cent, making the true power 4.4 kilowatts, or 5.9 electrical horse-power intake. The speed was 100 feet per minute. It is a pity that some tests were not made with this machine also under a reasonable load, so that an intelligent comparison might have been drawn with direct-current performance. The underload test, however, is useful as indicating how such motors compare with direct-current machines for apartment-house elevators and others where full load is exceptional. A 12½-h.p. direct-current motor, for example, that was tested with a load of about 1500 pounds, overbalanced 900 pounds, required 16½ kilowatts to start and 8.8 kilowatts at a car speed of 200 feet per minute.

Reducing the two performances to a common basis, the 15-h.p. induction motor performed a net duty of 70,000 foot-pounds a minute with an intake of 4.4 kilowatts, while the duty of the direct-current machine was 120,000 foot-pounds a minute, with an intake of 8.8 kilowatts. As the car speed of the latter outfit was exactly twice that of the alternating-current equipment, the friction load was doubtless considerably greater, so that the two performances may be reasonably considered as about equal as to running economy. At starting, however, the alternating-current machine took from the line about 2½ times the true power per unit of available torque that was required by the direct-current machine, to say nothing of the so-called wattless current. This is an encouraging showing, however, for the induction motor, and indicates that its satisfactory application to elevator and crane service is not by any means a hopeless problem.

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Wattless Current.

The number of requests received lately for an explanation of "wattless" current indicates that the term is not so generally understood by beginners in alternating-current work as we had supposed. To begin with, there is no such thing as a wattless current. Current cannot be made to flow without the expenditure of energy, the rate of which expenditure is expressed in watts. The current, or more accurately, component of a current, that is commonly termed "wattless" would better be called "useless," as that adjective describes it accurately and the former is simply absurd. Many writers now-a-days call it "idle" current, which is better than "wattless," but not exactly definitive, because it is not idle except as to useful work; on the contrary, the heating of conductors by such currents is ample evidence that they are extremely and perniciously active.

When an alternating current is passed through an inductance, such as a coil of wire wound on an iron core, or a condensance such as a condenser or a leyden jar or an over-excited synchronous motor, the current does not rise and fall in strength in perfect unison with the e.m.f. impressed at the terminals of the inductance or condensance. In the case of an inductance the current lags behind the e.m.f. in its alternations, so that when the current reaches its maximum, in either direction, the e.m.f. has passed the maximum point in that direction and is decreasing in strength. Thus, if the maximum e.m.f. is 1414 volts and the maximum current 50 amperes, to take convenient figures, and the current lags one-tenth of an alternation behind the e.m.f., the current will have attained a strength of only 40.45 amperes when the e.m.f. is at its maximum value, and following the lag through the cycle, when the e.m.f. reaches zero the current will still have a strength of 29.39 amperes. This proportion of the total current is said to be "wattless" because when the strength is at this value the impressed e.m.f. is considered to be at zero and there is no e.m.f. with which the current can combine to produce power. The figure 29.39, applied to the so-called "wattless" current, represents the maximum useless current, the effective value being $29.39 \times 0.707 = 20.78$ approximately.

As before stated, this proportion of the current is not wattless except as regards its availability in combination with the e.m.f. for power-producing purposes. It requires a part of the impressed e.m.f. to force it through the conductor that it traverses, and wastes a certain amount of power in heating that conductor. For example, if the current of 50 amperes maximum (35.35 amperes effective) mentioned above were passing through the windings of a motor and the resistance of those windings were 2 ohms, the loss in the windings would be $35.35^2 \times 2$ (I^2R) $= 2500$ watts, of which $20.78 \times 20.78 \times 2 = 836.617$ watts would be due to the useless proportion of the current and the remainder to the power-producing portion. Hence it will be clear that the terms "wattless" and "idle" are both misnomers.

DESIGN FOR A HIGH-CAPACITY STORAGE BATTERY.

BY J. C. BROCKSMITH.

The storage battery which is here described and shown in working drawings is intended for use in connection with the electric motor-cycle described in the March and April numbers of the AMERICAN ELECTRICIAN, and it may be substituted for the Planté type or sawed plate battery described last month without making any changes in the construction of either the battery box or containing cells.

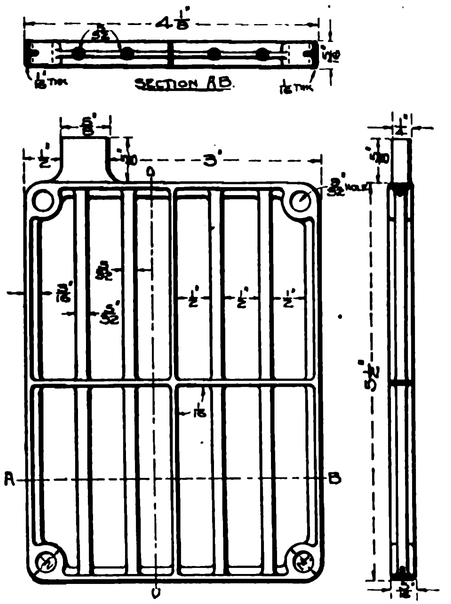


FIG. 1.—POSITIVE GRID.

The present battery has a considerable advantage over the electro-chemically formed element previously shown in the matter of specific capacity, as it gives an increase in capacity of over 50% while the weight of the complete cell is about 20% less than that of the other cell. The capacity of the present battery in watt-hours per pound of complete cell is more than double that of the battery previously described, though its durability will, of course, not be quite as great.

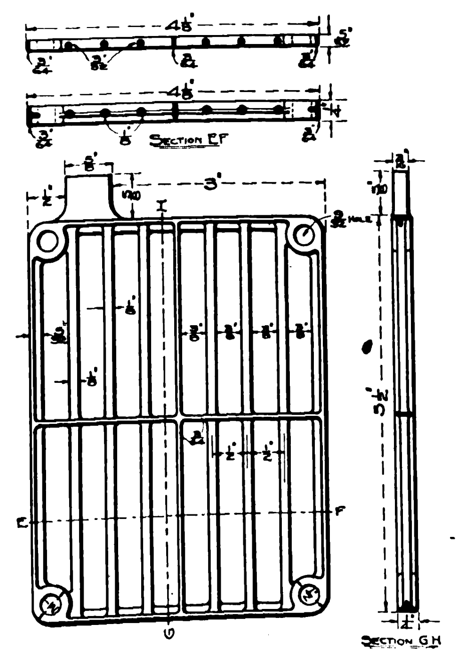


FIG. 2.—NEGATIVE GRID.

The battery is of the lead peroxide—sulphuric acid—metallic lead type, and of the form in which the active material, or material which is to become active, is mechanically applied to a metallic supporting and conducting grid. It is especially designed to have a large output or capacity per unit of weight of the complete cell, and to this end the proportion of active material present in a plate has been greatly increased relatively to the weight and volume of the grid itself. This has been accomplished, however, in such a manner that the durability of the whole is not seriously affected thereby.

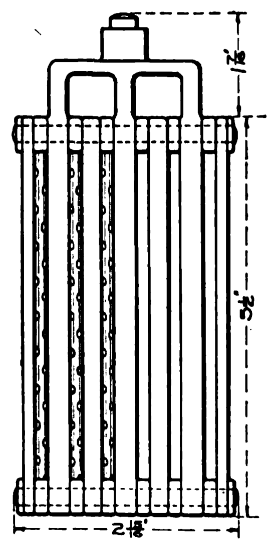


FIG. 3.—COMPLETE ELEMENT.

The requirements in the positive and negative grids being somewhat different, these will be shown and described separately.

The positive grid, of which the details are shown in Fig. 1, consists of a light rectangular frame having sides of T-shaped sectional outline, and provided at the four corners with circular bosses which are drilled, punched, or cast with holes for the reception of certain screw rods. This open frame may be further stiffened and strengthened by means of a vertical and a horizontal cross rib intersecting at the center of the grid, as shown.

The frame serves merely as a gauge to give a definite form and thickness to the mass of active material contained in it. For conducting the current to and from the active material a series of round conducting rods is provided, extending preferably in a vertical direction and terminating in the frame and cross ribs.

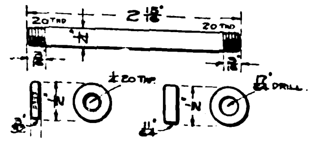


FIG. 4.—ROD, NUTS AND WASHERS.

The positive grid being the one which is most subject to electrolytic deterioration, it is preferable to use in this grid conductor rods of considerable size (5/32 inch diameter has been adopted in this case), and to space these rather far apart. In this way the amount of metal which it is necessary to put into the grid may be reduced without diminishing the cross-section of the conductors and hence their durability. A lug of substantial size is provided at the top of the grid for the purpose of making electrical connection with the finished plate.

The entire grid, as shown in Fig. 1, is, of course, to be cast in one piece. For this purpose an alloy consisting of lead with 10 per cent of antimony should be used in order to secure the best results as regards stiffness and lasting qualities.

The material which is applied to this grid and which later during the process of formation becomes the active material consists principally of minium, or red lead, with a slight admixture of litharge. This mixture of lead oxide is to be moistened with solution of ammonium sulphate, and while it is in a plastic condition the grid is filled until the material stands flush with the edges of the rectangular frame surrounding the grid.

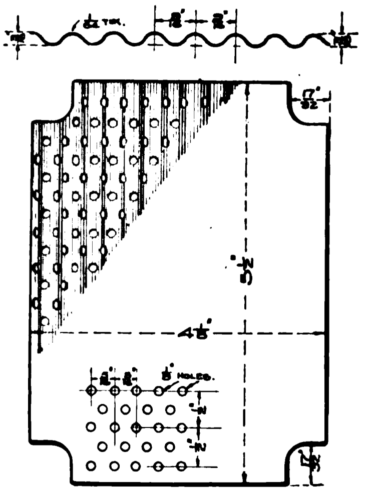


FIG. 5.—INSULATING SHEET.

The grid with its contents is preferably then subjected to a considerable pressure between some layers of absorbent material, such as blotting paper, which serves to remove the excess moisture and to further compress the material. This compressing process may be carried out by means of a screw press or other convenient means. It is, however, not essential to the success of the plate.

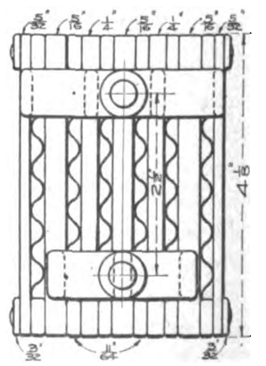


FIG. 6.—PLAN VIEW OF AN ELEMENT.

The use of ammonium sulphate solution as above indicated is preferred to the more common method of using dilute sulphuric acid, for the reason that it causes the material to set hard, without altering its nature so much as does the acid treatment, thereby

facilitating the process of formation which takes place later.

It will be noted when the plate has been pasted as described, that the conductor rods or bars are entirely embedded in the active material, the result of this arrangement being that they are thus protected to a large extent from electrolytic action, and serve as conductors only. A further advantage of this construction is that a continuous surface of active material is exposed to the electrolyte, thereby rendering available the maximum amount of surface for action of the electrolyte upon the active material.

If it is desired to do so, the exterior edges of the metallic frame which are exposed to the electrolyte may be protected from any action by coating these portions with acid-proof paint or similar material.

In the negative grids, illustrated by Fig. 2, a rectangular frame is used similar to that of the positive except that it can be made lighter in section and also of less depth, so that the finished plate is only about 75 to 80 per cent of the thickness of a positive plate. And, since the negative grid is little, if at all, subject to electrolytic deterioration, it is preferable to make the conducting rods or bars much thinner than in the positive, and to space them closer together, thus securing a better distribution of current over the surface of the plate.

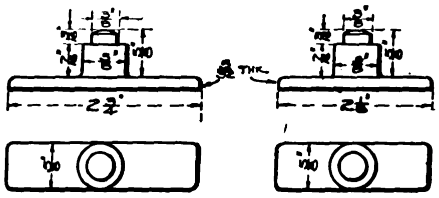


FIG. 7.—TERMINALS.

The two end negatives, of which a section is shown in Fig. 2, are made only about one-half the thickness of the other negatives, for the reason, of course, that as they are active on one face only they will require only one-half the amount of active material required by the other negatives, which are active on both faces. The end negatives are shown $^{5}/_{32}$ inch thick, the middle negatives being ¼ inch thick.

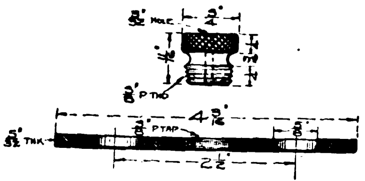


FIG. 8.—COVER.

All negative grids are to be cast from an alloy of lead with 10 per cent of antimony, as in the case of the positives.

The material which is used for filling the negative grids is composed of litharge with a slight admixture of minium. In this case the mixture is moistened with a very dilute solution of sulphuric acid, it being impracticable to use ammonium sulphate because of the rapidity with which the reaction takes place in the latter case.

The grid is filled with the mixture, in much the same manner as in the case of the positive, and the plate is then laid aside to harden and dry.

After plates have been prepared as described, a sufficient number to constitute a complete element are assembled in the form shown in Fig. 3, where there are shown seven plates composing an element, three of which are positive and the remaining four negative. Positive and negative plates are alternately disposed, and the negatives may be distinguished by the fact that they are thinner.

As a means for separating and insulating the various plates a number of rods and washers of insulating material, such as hard rubber, are provided. The rods have threads cut on their extremities and are made sufficiently long to pass entirely through the set of plates and allow some space at the ends to screw on small nuts of the same material.

These rods, together with their nuts and washers, are shown in detail in Fig. 4. The washers are made of a thickness to give the proper space of separation between the plates, which is $^{11}/_{64}$ inch. All the parts shown in Fig. 4 may be made from hard rubber rod or non-conducting composition.

In addition to the rods and washers which serve to bind and space the plates in permanent form, some perforated and corrugated sheets of hard rubber or similar material, shown in Fig. 5, must be provided as a precaution against the short-circuiting of the element by material lodging between the plates. Any insulating material may be used for this purpose which will resist the action of the electrolyte and yet permit free circulation of it. Hard rubber is the best but also the most expensive material to use.

Reliance is not to be placed on the corrugated and perforated sheets alone to effect separation and insulation of the plates under all circumstances. If the electrolyte in a cell becomes heated for any reason, these sheets are apt to become flattened and therefore useless as separators. Taken in connection with the insulating rods and washers, however, they form a very secure and satisfactory arrangement for separating and insulating plates. Fig. 6 shows a plan view of the complete element with the corrugated separators in position between the plates. It is the practice in some high-capacity batteries to perforate the active material of the plates with a series of holes to facilitate the circulation of the electrolyte and its action upon the plate. It is not recommended that this method be adopted in the battery here shown, as the benefit to be derived has been found by comparative trials to be very slight, and certainly does not compensate for the extra labor involved in the operation.

When the plates have been assembled and properly spaced, it is necessary to connect plates of the same polarity in multiple with each other, and for this purpose a pair of terminals is provided, as shown in Fig. 7. Each of these is made long enough to span all those plates which it is intended to connect. These terminal pieces may be cast from antimonious lead, as are the grids, and are then burned in position across the connecting lugs, which have been provided on the plates for this purpose. In doing this work a fillet of metal should be left in the angles of the joints to strengthen and protect them. To further protect the terminals and joints from any undue action of the electrolyte, it is advisable to coat these parts with acid-proof paint.

The style of terminals shown is, of course, intended for the use of a soldered connection between the various cells composing the battery; with a slight change in the design of the terminals a screw connection might be used, though it will not be so satisfactory in the long run.

When a sufficient number of elements have been completed in this way, they may be connected in series, and must then be "formed" by the continuous passage of a direct current in one direction through the cell until all the material on the positive plate has been oxidized to peroxide of lead, and all the material on the negative plate has been reduced to metallic lead.

During the process of formation it is preferable to use a very dilute solution of sulphuric acid, of much lower strength than the regular electrolyte, in order to avoid as much as possible the sulphating of the material, which, if it occurs, will delay the forming process.

The cells are to be connected to the circuit in such manner that the current enters the element at the positive terminal and should be maintained always at the maximum strength that the cell will accept without the evolution of gases. This current is usually small at first, but can be increased as the forming process proceeds.

When formation is complete, and this is best determined from the appearance of the plates, which should be of uniform color throughout (brown for the positives and gray for the negatives), the forming solution may be turned out and replaced with the regular electrolyte, consisting of sulphuric acid and water mixed to a specific density of from 1.250 to 1.275. It is hardly necessary to state that the electrolyte must be cold before it is placed in the cells.

To properly form the cell here described will require from 150 to 200 ampere-hours, providing no energy is lost by allowing the cell to liberate gas. When the cells have been properly formed and are seen to be in good condition, the next step is to carefully seal the top of each jar to render it water-tight, and thus prevent loss of the electrolyte through evaporation or spilling. For this purpose some hard rubber covers and plugs are required, which are shown in detail in Fig. 3. The cover is simply a piece of hard rubber sheet $^{1}/_{8}$ to $^{5}/_{32}$ inch thick, of such size that it fits snugly into the top of the jar, and drilled with holes for the terminals and plug. The central hole is tapped to receive a screw plug, which is removed for replenishing the electrolyte, when necessary.

The plug may be turned from hard rubber rod and is threaded to fit the tapped hole in the cover; it is drilled with a $^{3}/_{32}$-inch hole, extending clear through, which serves as a vent for any gases which may be liberated in the cell.

The compound to be used for sealing is best obtained in prepared form from some battery manufacturer. It usually requires to be heated, and while in a liquid state is poured into the space at the top of the jar, and will then adhere firmly to the sides of the jar, cover, terminals, etc., rendering all the joints and seams impervious to the acid contained in the jar.

Fig. 9 shows a plan and elevation of the complete cell in a hard-rubber jar. This view indicates the space that the various parts of the cell must occupy in order to bring the over-all dimensions within the prescribed limits. The jar is of the same dimensions as the one described last month, viz: 3¼ x 4½ x 7 inches, outside measurement.

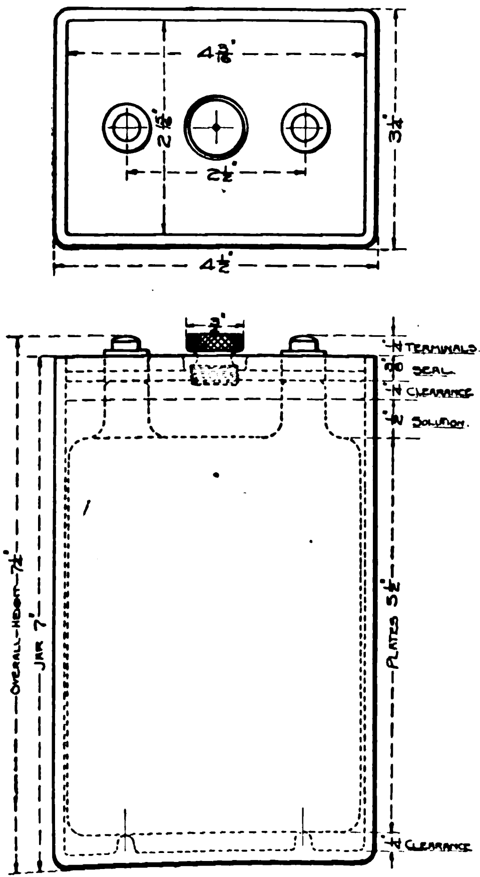


FIG. 9.—COMPLETE CELL.

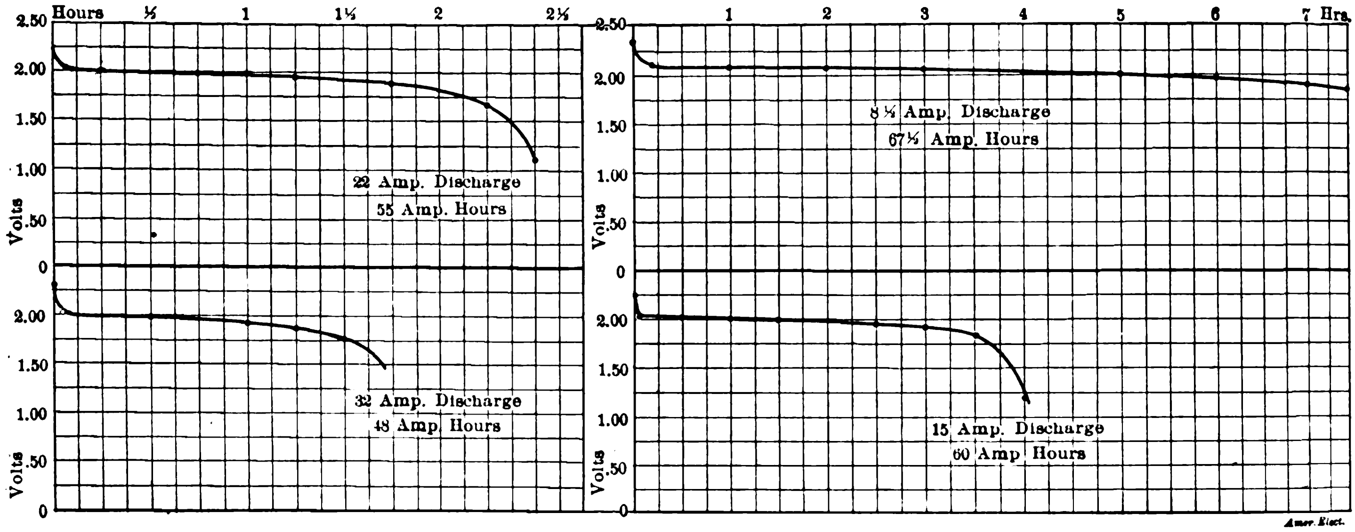


FIG. 10.—DISCHARGE CURVES AT VARIOUS RATES.—FIG. 11.

The battery is now ready for use, and a few simple rules in this connection may not be amiss. The cells should be operated so as to avoid gassing, which with proper care is not so difficult as it may appear. Gassing not only indicates a waste of energy, but it also injures the plates by softening the active material if permitted to continue for any great length of time. During the discharge of the cells there are no special precautions necessary, as it is practically impossible to produce gassing unless the elements are deliberately short-circuited.

During the charging of the cells 90 per cent of the charge can be gotten in with an e.m.f. of less than 2.3 volts per cell when charged at a uniform low rate, and no gassing occurs until the e.m.f. reaches 2.4 volts per cell. As soon as 2.4 volts is reached bubbles of liberated gas appear in the solution. In fact, they seem by their presence to cause a sudden rise in the voltage, due perhaps to the increased resistance of the electrolyte when in a state of ebullition. Therefore, when the voltage reaches 2.4 the charging current should be promptly reduced, whatever may have been its previous value.

When the cells are empty and the charging is first begun it will be found that they will accept the charging current at a comparatively high rate, and by taking advantage of this fact the battery can be charged in a short time whenever the circumstances require it.

To charge the battery in two hours a variable charging rate should be adopted, about as follows:

First hour, current 35 to 40 amperes...	Voltage rising from 2.3 at beginning to 2.4 at close.
Next half hour, current 20 to 25 amps.	Voltage rising from 2.31 beginning to 2.4 at close.
Last half hour, current 10 to 12 amps.	Voltage rising from 2.32 at beginning to 2.4 at close.

Total charge, 55 to 60 ampere-hours. By continuing to charge at a low rate of from 2 to 5 amperes, the remainder of the charge can be gotten in and the voltage will rise to 2.5 or even 2.6 volts at the extreme end of the charge, depending on the value of the current flowing. Where it is desired to save time, however, this latter portion of the charge may well be omitted, as it adds but little to the capacity and requires a disproportionately long time to carry out.

All the above values of voltage are understood to be taken with the current on. The above charging rate applies only where the cells are to be charged from empty to full in two hours. When the cells are only partially discharged, different values of current will have to be adopted, depending on the state of discharge.

When sufficient time is allowable, as for instance in all-night charging, a low uniform rate of from 6 to 8 amperes may be adopted, which will give about 65 to 70 ampere-hours total charge.

Some further general rules for the care of storage batteries are as follows: Acid and water for making electrolyte should be free from impurities, preferably chemically pure. The mixture should be allowed to cool before being placed in cells. It is best prepared a day before using.

Cells should not be discharged below 1.75 volts per cell, and should not be allowed to stand discharged for any length of time.

Cells should be gone over occasionally with a voltmeter and a hydrometer to ascertain their individual condition, and any low-reading cell should receive immediate attention.

Plates should be well covered at all times by the solution, any evaporation being compensated for by the addition of pure water.

If cells are to remain out of use for a considerable time, 4 to 6 months, they should be given a full charge, and then the electrolyte removed and clean water substituted and the jars tightly closed to prevent evaporation. When cells are standing idle for shorter periods of time they should receive a short charge about once in two weeks.

Figs. 10 and 11 are curves taken from a battery of the type here described, and the following is a summary showing the weight and capacity of the battery, and also the weight and mileage of the electric motor cycle, previously described, when equipped with this battery.

SUMMARY—HIGH-CAPACITY CELL.

Three positives 4⅛" x 5½" x 5/16" thick; four negatives 4⅛" x 5½" x ¼" x 5/32" thick. Total positive active surface, 136 sq. ins.

Weight of plates and connections, dry, 7 lbs.; weight of electrolyte, 1.275 sp. gr., 1½ lbs.; weight of rubber cell and separators (estim.), 1 lb.;' weight of cell complete, 9½ lbs.

	Amps.	Hrs.	Amp. hrs.
Capacity of cell down to 1.75 volts; electrolyte, 1.275 sp. gr.	8½	8	67½
	15	4	60
	32	1½	48
	22	2½	55

Current on short-circuit, 375 amperes.

Watt-hours per pound of complete battery, 14.2.

(Watt-hours per pound of other battery, 6.7.)

Note.—As shown by the curves, the voltage holds up well, being above 2 volts (average value) on the 8-hour discharge, while on heavy discharges which exhaust the charge in 1½ hours the last voltage does not fall below 1.9 volts until the last half hour of the discharge.

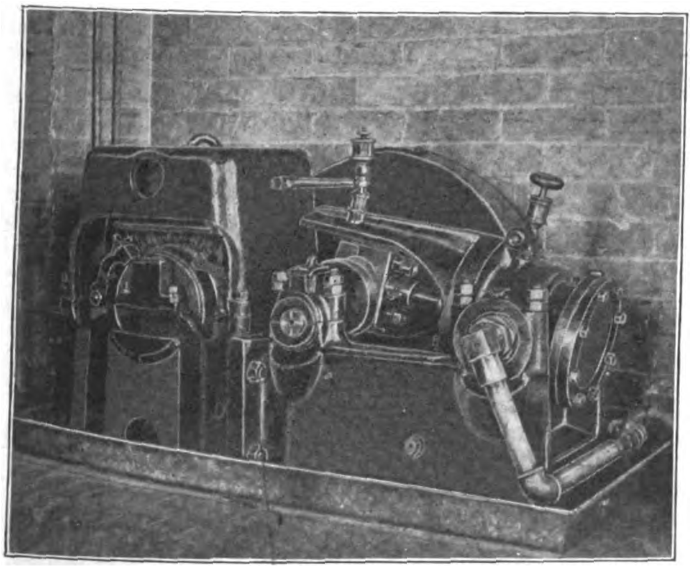
ELECTRIC MOTOR CYCLE.

Weight of battery, 10 cells, 95 lbs.; weight of motor complete, 40 lbs.; weight of frame, etc., 40 lbs.; total, 175 lbs.

No. or riders.	Gear ratio.	Max. speed. M.P.H.	Discharge rate amps.	Hours run at max. spd.	Miles on one change.
2	8	12	15	4	48
1	8	14	12	5	70
2	5	17	22	2½	42
1	5	22	20	2¾	57
2	3	24	32	1½	36
1	3	30	28	1¾	52

Note: The above values are figured for the best conditions of operation; any conditions less favorable, such as bad roads, head winds, hill climbing, the figures for speed and mileage, which therefore can only be taken as approximately indicating the capabilities of the machine.

Application has been made for a patent covering the details of construction of the battery, which is described in this article, but there will be no objection to the use of the design by amateurs or experimenters in a non-commercial way.



MOTOR-DRIVEN COMPRESSOR.

COMPRESSED AIR IN CENTRAL STATION AND RAILWAY SERVICE.

BY ARTHUR B. WEEKS.

When one has had the use of compressed air for cleaning out dynamos, electric cars and motors, he wonders how he managed to get along so many years without its use. A good manager wants things kept clean, and that this required a great deal of time in the old way is well known. Aside from blowing out ordinary dust, the advantages of air in cleaning dynamos and motors are numerous. It will blow out copper or carbon dust around brush holders and insulating bushings, and from places which it would be impossible to reach without taking the machine apart, various shaped nozzles to meet the requirements of different kinds of work being made.

Most street railway systems go over their apparatus in this way only once in six months, which is usually quite sufficient, where there is a nightly inspection of the entire equipment. A day inspection is advocated by many instead of night inspection, but that is a matter depending upon local conditions. In the general cleaning up at such times, nothing but scraping will remove the accumulated grease and oil. Compressed air, however, is valuable in blowing out an armature; especially one that is undergoing repairs. Insulating paint will not adhere to dust, and twice as much as is absolutely necessary is likely to be used if the armature or field is not thoroughly cleaned. Waste cannot remove dust from between the wires. Bellows have been used for years, and are still used, for such purposes; but the best of them cannot meet the requirements, and they are almost always out of order or cannot be found. The larger the plant, the more important it is to have compressed air for cleaning purposes.

There is also another use for air which is especially valuable. Frequently there are drilling jobs which could be done in a very short time by the use of a pneumatic drill. The pneumatic drill can be used in places which seem almost inaccessible under a car. The drilling can be done without dismounting. In the car, under it, or anywhere, the drill can be set up.

In one railway plant which the writer recalls, a blacksmith's press was driven by an Edison motor erected in the blacksmith shop. The repair shop was in the car house, at the farther side of an adjacent building, with no other way of communication than by rolling the material on a truck for a distance of two blocks between rows of cars and across transfer tables. One cannot readily imagine a worse condition, but this is no exaggeration; and there are other cases just as bad. There was a time when this blacksmith shop had no motor to drive the drill, and the drilling was done by hand. All the frogs and switches of the twenty-six-car line were reconstructed, and all the drilling done by a hand press.

The air compressor illustrated herewith is very compact, and seldom requires any adjustment. The motor is thoroughly protected from injury. The commutator is in plain view, and easily accessible; the gears are encased. This compressor is used for blowing-out purposes only, and its normal pressure is sixty pounds. The entire motor and compressor stand in a tin pan, which catches the accumulated oil.

In the larger power houses of the country the dynamos are periodically shut down in turn and blown out by compressed air, which is simply indispensable here. Where cars are equipped with air brakes, it is an easy matter to get air for cleaning out the cars, of course; where they are not, a compressor of the general type here shown should be provided.

The pressure used for ordinary cleaning out will not answer for pneumatic drills, as their pressure must be greater, and a more expensive machine would be necessary; the additional expenditure would hardly be justified in a small plant.

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A HANDY INSULATION TEST AND SOME SHOP NOTES.

BY WALTER MUNROE.

In an electrical installation it is of the greatest importance that the insulation resistances of both machines and lines shall be kept at a safe figure. The actual remedying of a fault when once found will not be taken up here, but a simple and efficient method of detecting faults will be described. A sensitive direct-current voltmeter is required, the resistance of which is accurately known, and a source of constant-potential current of considerable e. m. f. A test with a 150-volt Weston voltmeter will be described. The resistance of such an instrument will be about 15,000 ohms, but the exact value is marked under the cover of the case of each instrument. A fairly high voltage (giving a high scale reading) will be required; say, 120 volts. The supply e. m. f. should be constant while the readings are taken.

First, the voltage of the supply is taken and recorded; call this reading *E* (see Fig. 1). Then the voltmeter is connected in series with the insulation or armature, the whole connected across the mains, and the voltmeter again read; call this *V*. This

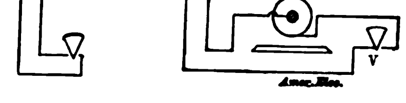


FIG. 1.—INSULATION TEST CONNECTIONS.

will be small if the insulation is good, and 120 for a dead ground; suppose this second reading to be 2. Let the voltmeter resistance, 15,000 ohms, be represented by *R*. Then by substituting these values in the formula

$$\frac{E}{V} - R - R = X$$

we get the insulation resistance, *X*.

When the insulation resistance is high and the idea is merely to see that it is beyond a certain value considered safe, the last *R* may be omitted, leaving the formula

$$\frac{E}{V} - R = X.$$

Substituting, $E = 120$; $V = 2$; $R = 15{,}000$; we have

$$\frac{120}{2} \times 15{,}000 = 900{,}000 \text{ ohms},$$

a very safe value. In case no deflection is shown for *V*, a careful examination should be made to see that the lead wires are intact, that the voltage is still on the mains, and that connections are properly made. It is best to take several pairs of measurements to avoid the chance of a change of voltage between readings.

It sometimes happens that the armature or the field coils of a machine become very damp, or even saturated with water. The most natural way of drying would seem to be the heating or baking of the part in an oven or similar contrivance, but such facilities are not always at hand. Again, by this method the heat is applied to the surface and must work its way in and the moisture again work its way out in vapor. The best plan is to pass a current through the armature or field, as the case may be, of a value not over its full-load capacity. This may be obtained from another machine, but a neat way (particularly applicable to an armature) is to have the machine supply its own current.

There are two precautions to be observed; the first is to keep the voltage very low, in order that the insulation may not be punctured while in a weakened condition, and the second is to keep the current within reasonable limits. The armature may be short-circuited at the brushes or preferably as a precaution (at first at least) through a low resistance, and then rotated slowly. With an armature in circuit provided with a short-circuiting switch, the current can then be adjusted to not over full-load value. The field current should be very low at starting. Where a machine has an uneven number of pairs of poles, as six, and a two-circuit single winding, two pairs of the poles may be reversed, leaving only one pair of poles effective, which makes it easier to control the voltage. It should always be remembered that the armature is short-circuited and that a small voltage only is required to get the necessary current. Where a green armature is being dried out by current from an outside source, it should be rotated occasionally to prevent the shellac from running down in one direction.

CONDENSING VS. NON-CONDENSING.

BY CHAS. L. HUBBARD.

The value of a condensing apparatus to any engine depends largely upon the temperature of the injection water, the steam pressure, the cut-off of the engine, and to a certain extent the engine itself. The quantity of water required to completely condense the steam from an engine depends on two conditions, the total heat and weight of steam, and the temperature of the injection water. With 26 ins. of vacuum and the injection water at 70° or less, the required weight of injection water will be from twenty to thirty times that of the steam to be condensed. If the temperature of the injection water is lower, less water will be required, and if higher, the amount must be increased; for example, at 80° the water required is thirty-five times the quantity of steam condensed, and at 90° a quantity of fifty-two times that of the feed water is required. The amount in each special case can be computed theoretically by the following equation:

$$Q = \frac{S - (t_d - 32)}{t_d - t_e},$$

in which Q = weight of injection water per pound of steam,

S = total heat (above 32°) of a pound of exhaust steam,

t_e = temperature of injection water,

t_d = temperature of discharge water.

In using this formula it is necessary to know the terminal pressure of the steam in the cylinder at the end of expansion in order to determine the total heat of the exhaust steam. This can be determined near enough for all practical purposes from Table I herewith. The temperatures of the injection and discharge water must be assumed. In practice it is customary to take the former at about 70° as a fair average in summer time. The temperature of the discharge water generally ranges from 110° to 120° for ordinary conditions of vacuum, which means a vacuum of from 24 to 26 inches. Probably 70° and 110° represent about the average, and these may be taken in making the computations for the quantity of condensing water required. In making computations for a year's run, one should take the average temperature of injection water at about 50°. Assume the case of a 200-h.p. engine with 5% clearance, using 20 lbs. of steam per horse-power per hour, and cutting off at ⅛ stroke; a boiler pressure of 130, gauge; and temperatures of injection and discharge water 70° and 110° respectively. Find the quantity of condensing water required per hour?

TABLE I.
Terminal Pressure Ratios.

	Per Cent.	Clearance.				
Cut-Off.	0	1.75	3	5	7	9
1-10	.1	.115	.126	.143	.159	.174
1-8	.125	.14	.150	.167	.182	.197
1-6	.167	.181	.191	.206	.221	.235
1-5	.2	.214	.223	.238	.252	.266
1-4	.25	.263	.272	.286	.299	.312
5-16	.312	.324	.332	.345	.357	.369
1-3	.333	.344	.353	.365	.377	.388
3-8	.375	.386	.392	.405	.416	.427
2-5	.4	.410	.417	.428	.439	.449
7-16	.437	.447	.454	.464	.474	.484
1-2	.5	.509	.514	.524	.533	.541
5-8	.625	.632	.636	.643	.649	.656
3-4	.75	.754	.755	.762	.766	.771
4-5	.8	.804	.806	.809	.813	.816
9-10	.9	.902	.903	.905	.906	.908

To find the (theoretical) absolute terminal pressure, multiply the absolute initial pressure by the number opposite the given cut-off and in the column corresponding to the percentage of clearance.

Table I shows that the terminal pressure ratio is .167, and as the initial pressure is 130 + 14.7, the terminal pressure is (130 + 14.7) × .167 = 24 lbs., and a steam table shows that the corresponding total heat is 1154.5. The following values, therefore, may be substituted in the formula: $S = 1154.5$; $t_e = 70$, and $t_d = 110$. So that

$$Q = \frac{1154.5 - (110 - 32)}{110 - 70} = 26.9 \text{ pounds},$$

practically. The total weight of steam used per hour by the engine is 20 × 200 = 4,000. Therefore, 4,000 × 26.9 = 107,600 pounds of condensing water required per hour. This measures 107,600 ÷ 8.3 = 13,000 gallons, roughly.

The reason for the above formula is evident. One pound of steam at 24 pounds pressure (absolute) contains 1154.5 heat units above 32°; that is, if the steam were condensed and cooled to 32 degrees, 1154.5 heat units would be given off. But in the example it is only cooled to 110°, and as one heat unit will raise the temperature of one pound of water one degree, one heat unit will remain in the condensed steam for each degree that its final temperature remains above 32°. Therefore, the heat given out by condensing one pound of steam at 24 pounds pressure and cooling it to 110° is 1154.5 — (110 — 32) = 1076.5 heat units. The heat absorbed by one pound of water in raising it from a temperature of 70° to 110° is 110 — 70 = 40 heat units. Therefore, 1076.5 ÷ 40 = 26.9, the pounds of water which will be required to absorb the heat given off by the condensation and cooling of one pound of steam under the conditions stated in the example.

The matter of subtracting 32° from temperature d, affects the result but little, and is is often omitted in practice, and the formula written

$$Q = \frac{S - t_d}{t_d - t_e},$$

but for purposes of demonstration it is necessary to include it.

The advantage to be gained by the use of a condenser is an increase in the power of the engine with the same steam consumption, or a saving in steam when delivering the same power. The power exerted by a steam engine during a single stroke of the piston is due directly to the difference between the pressures acting on the opposite sides of the piston. A vacuum does not in itself give power, but its effect is to reduce the resistance on the exhaust side of the piston, and therefore adds just so much to the steam side.

The value of a vacuum of 26 ins. of mercury upon the exhaust side of a steam engine piston, making due allowance for the cost of production, may be approximated by considering it equivalent to a net gain of 12 lbs. mean effective pressure per square inch of piston area. This effect may be shown graphically by means of an indicator diagram, as in Fig. 1. Let the full line represent the diagram when the engine is running non-condensing. If a condenser be connected to the exhaust outlet, and the points of cut-off and release remain the same, the back pressure line will drop to the position shown as dotted, and an effective pressure represented by the height included between the two back pressure lines will be added to the steam side of the piston throughout its full stroke. This is equivalent to increasing the mean effective pressure a like amount, which under ordinary conditions may be taken as 12 lbs., as previously stated. From this it is evident that the amount of power gained bears practically the same ratio to the power developed by the engine when running non-condensing, as 12 lbs. does to the mean effective pressure when running under the same conditions; or expressed in the form of a proportion, *h.p* : *H.P.* :: 12 : *M.E.P.*, in which *h.p* = gain in horse-power by running condensing, *H.P.* = horse-power of engine when running non-condensing, *M.E.P.* = mean effective pressure of engine when running non-condensing.

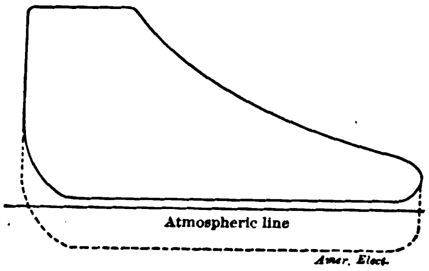


FIG. 1.

From the above it is evident that if the mean effective pressure of an engine when running non-condensing is known, it is easy to determine the percentage of gain in power which would be obtained by the use of a condenser by dividing the mean effective pressure into 12, thus: 12 ÷ *M.E.P.* = proportion of increase, and 1200 ÷ *M.E.P.* = percentage of increase. Changing the statement in proportion to the form

$$h.p. = \frac{M.E.P.}{12\ H.P.}$$

gives a short way of finding the actual increase in power, and $H.P. + \frac{12\ H.P.}{M.E.P.}$ = the horse-power of an engine running condensing, if its horse-power when non-condensing is *H.P.*

The approximate mean effective pressure for any given case may be found by the use of Table II. The ratios given in this table are for absolute pressures, and their use can best be shown by a practical example. A non-condensing engine with 5% clearance cuts off at ¼ stroke; the boiler pressure is 75 lbs. gauge, what is the mean effective pressure? 75 lbs. gauge = 75 + 14.7 = 89.7 lbs. absolute. The ratio for ¼ cut-off is .626; therefore, the mean effective pressure is 89.7 × .626 = 56 lbs., roundly, but this is on the supposition that the engine exhausts into a perfect vacuum.

Under ordinary conditions the back pressure on the piston of an engine exhausting into the atmosphere will be about 17 lbs. absolute, so that in the above example one must subtract 17 from the result found, which will give 56 — 17 = 39. Briefly, we may write [(*p* + 15) × *ratio*] — 17 = *M.E.P.* for a non-condensing engine, and [(*p* + 15) × *ratio*] — 3 = *M.E.P.* for a condensing engine, in which p is the boiler gauge pressure.

Another example such as commonly comes up in practice is the following: What will be the percentage of gain in power by connecting a condenser to an engine cutting off at 1/3 stroke and using steam at 85 lbs. gauge pressure? If the engine is rated at 125 horse-power when running non-condensing, what will be its power when running condensing?

TABLE II.
Mean Pressure Ratios.

	Per Cent Clearance.					
Cut-Off.	0	1.75	3	5	7	9
1-10	.330	.354	.369	.392	.413	.432
1-8	.384	.405	.418	.438	.457	.474
1-6	.465	.481	.492	.509	.524	.538
1-5	.522	.535	.545	.559	.572	.584
1-4	.597	.607	.615	.626	.636	.646
5-16	.676	.684	.689	.698	.706	.713
1-3	.699	.707	.713	.719	.727	.734
3-8	.742	.749	.753	.759	.765	.771
2-5	.766	.771	.775	.781	.786	.792
7-16	.799	.804	.807	.812	.819	.820
1-2	.846	.850	.852	.856	.858	.862
5-8	.919	.920	.921	.923	.925	.926
3-4	.966	.966	.966	.967	.968	.969
4-5	.978	.978	.979	.979	.980	.981
9-10	.995	.995	.995	.995	.995	.995

To find the mean pressure exerted throughout the stroke, multiply the absolute initial pressure (above a vacuum) by the number opposite the given cut-off and in the column corresponding to the percentage of clearance, and deduct the absolute back pressure.

[(85 + 15) × .72] — 17 = *M.E.P.* = 55.

Then $\frac{1200}{55}$ = 21.8 per cent gain in power,

and 125 + $\frac{12 \times 125}{55}$ = 152 = the horse-power that will be developed running condensing.

Another way to look at the matter is to figure the saving in fuel by running condensing, where the power is kept constant by changing the cut-off. This is illustrated graphically in Fig. 2, which shows two diagrams taken from the same engine, the first, shown by the dotted line obtained when running non-condensing, and the second when running condensing. The areas of the two diagrams are equal, so that the work done per stroke is the same in each case. Suppose for example that cut-off occurs at ¼ stroke in the first case and at 1/6 in the second. Then, neglecting clearance, the difference between ¼ and 1/6 of a cylinderful of steam is saved at each stroke. The percentage of saving may be roughly obtained as follows: Assuming the sectional area of the cylinder to be 1 sq. ft., the volume of steam used per stroke in the first case will be 1 × .25 = .25 cu. ft., and in the second case 1 × .166 = .166 cu. ft. The saving per stroke will be .25 — .166 = .084 cu. ft. per stroke will be .25 — .166 = .084 cu. ft. or .084 ÷ .25 = 33 per cent, roughly.

Take the case of a 24-in. x 42-in. non-condensing engine running at a speed of 150 revolutions per minute, having 50% clearance and cutting off at ⅓ stroke; boiler pressure 105 pounds, gauge. What will be the saving in fuel by attaching a condenser and running the engine so as to develop the same power, if the water rate is 30 pounds per horse-power-hour and the efficiency of the boiler is such that one pound of coal will evaporate 9 lbs. of water? The method of making the calculations is as follows:

M.E.P. = [(105 + 15) × .72] — 17 = 69.4.

The next step is to find the new point of cut-off which will be required to maintain the same power of the engine when running non-condensing. In this case the initial and mean effective pressures remain the same, the only change being in the back pressure, so we may write [(105 × 15) *R*] — 3 = 69.4, and solve for *R*, as follows: 69.4 × 3 = (105 × 15) *R*; hence,

$$\frac{69.4 + 3}{105 \times 15} = R = .603.$$

Looking in the table of ratios we find that .603 corresponds to a cut-off a little less than one-fourth, which may be taken with sufficient fairness as the new point. The saving in steam per stroke will then be

$$(⅓ - ¼) \div 1/3 = \frac{.33 - .25}{.33} = .25, \text{ or } 25$$

per cent, roughly.

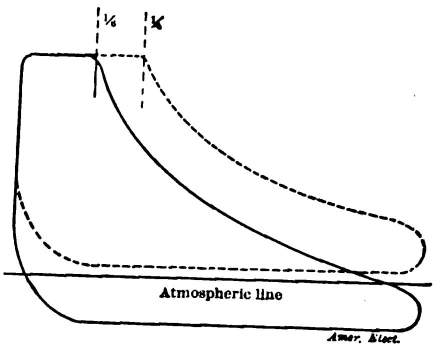


FIG. 2.

The weight of steam used by the engine when running non-condensing is from the conditions given in the problem, 998 × 30 = 29,940 lbs. per hour, and the coal required to generate this steam is 29,940 ÷ 9 = 3,327 lbs. With a saving in steam of 25 per cent, the saving in coal, being in direct proportion, will 3,327 ÷ + = 832 lbs. of coal per hour. In order to determine the actual saving in running expenses, the cost of the coal saved must be compared with the additional expense for condensing water, interest on the cost of the condensing apparatus and deterioration upon the same.

From this discussion it is evident that the value of a condenser depends entirely upon existing conditions, and to a great extent upon the relative cost of water and coal. In a subsequent article the advisability of installing a condenser when the exhaust steam may be used for heating purposes will be taken up as well as the subject of cooling towers.

Government Wireless Telegraphy.—Gen. Greely has approved the proceedings of the board of signal officers who had under consideration the proposals for the installation of wireless telegraphy stations in Alaska. The system invented by Prof. Fessenden will be installed at Nome and St. Michael. Gen Greely has also accepted the proposal of the Marconi Company to install a system between Ft. Gibbon and a point on the Tanana River, near Bates Rapids. The systems are to be worked ten days prior to their acceptance by the Signal Corps.

DETERMINING WIRE SIZES FOR ALTERNATING-CURRENT MOTOR CIRCUITS.

CLEAT AND KNOB WIRING.

The wiring for incandescent lights supplied from an alternating current system is comparatively easy to calculate, as it involves in most cases (conduit wiring) nothing further than the calculation necessary for direct-current circuits. The case of the alternating-current motor, however, is different, the motor having a power factor less than unity, and conduit wiring being less generally used. The current required for a given output is greater than in the case of a direct-current motor, and this increased current enhances the slight disadvantage of self-induction in the lead wires, so that in calculating motor wiring one has to take into account both the power factor of the machine and the self-induction of the line, in addition to the simple resistance of the lead wires.

The most convenient formula for drop in a single-phase or two-phase circuit supplying an induction motor is as follows:

$$100 \times \sqrt{\left(p+\frac{IR}{E}\right)^2 + \left(q+\frac{IX}{E}\right)^2} - 100 =$$

per cent drop.

In this formula E is the e.m.f. at the motor; I is the current per wire; R is the resistance of both wires of a single-phase circuit, or of two of the wires of either a two-phase or a three-phase circuit; X is the reactance of the two wires; p is the power factor of the motor, and q is the sine of that angle of which p is the cosine. In addition to the fact that this formula is extremely tedious and unwieldy in application, it has the disadvantage of being impossible of solution for any given drop. In other words, it is impossible to use the formula unless all of the factors except the drop are known. It cannot be used, for example, to ascertain the size of wire necessary for a predetermined drop.

The work of laying out motor wiring is also hampered by the fact that it is utterly impossible to prepare a single table which will cover all of the variable factors; indeed, not less than eight tables would be required for an ordinary range of motor work, while more than a dozen would be required for the usual range of primary winding.

The accompanying tables and diagrams have been prepared with a view to facilitating the calculation of motor wiring and eliminating the necessity for using troublesome formulas. The tables are applicable, as an inspection of them will show, to both 200-volt and 400-volt circuits of 60 cycles frequency, with the wires 3 ins. apart, one table applying to single-phase and two-phase circuits and the other to three-phase circuits. The diagrams are plotted for power factors

TABLE I.

For single-phase and two-phase circuits with wires 3 ins. apart, and 60 cycles frequency. Figures in body of table are ampere-feet; *i.e.*, amperes per wire × distance in feet. Impedance drop is in percentage of motor e. m. f.

Impedance drop at		Wire Sizes; B. & S. Gauge.											
200 V.	400 V.	0000	000	00	0	1	2	3	4	5	6	8	10
1		12,260	10,870	9470	8110	6780	5610	4640	3760	3010	2420	1540	973
1¼		15,320	13,580	11,840	10,140	8470	7020	5790	4700	3760	3020	1920	1210
1½		18,400	16,300	14,200	12,170	10,170	8420	6950	5640	4520	3630	2310	1460
1¾		21,460	19,020	16,570	14,200	11,860	9830	8110	6580	5270	4230	2690	1700
2	1	24,520	21,740	18,950	16,220	13,560	11,230	9270	7520	6030	4840	3070	1940
2¼		27,600	24,450	21,310	18,250	15,250	12,630	10,430	8460	6780	5440	3460	2190
2½	1¼	30,650	27,170	23,680	20,280	16,950	14,040	11,590	9400	7530	6050	3840	2430
2¾		33,720	29,890	26,050	22,310	18,640	15,440	12,750	10,340	8280	6650	4230	2670
3	1½	36,800	32,600	28,420	24,340	20,340	16,850	13,910	11,280	9040	7250	4610	2920
3¼		39,850	35,320	30,790	26,370	22,030	18,250	15,070	12,220	9790	7860	5000	3160
3½	1¾	42,920	38,050	33,150	28,400	23,730	19,650	16,230	13,160	10,540	8460	5380	3400
3¾		46,000	40,760	35,520	30,420	25,420	21,060	17,390	14,100	11,300	9070	5770	3650
4	2	49,050	43,470	37,900	32,450	27,120	22,460	18,550	15,040	12,050	9670	6150	3890
4¼		52,120	46,200	40,260	34,480	28,810	23,870	19,700	15,980	12,800	10,280	6540	4130
4½	2¼	55,180	48,900	42,630	36,510	30,510	25,270	20,860	16,920	13,560	10,880	6920	4380
4¾		58,250	51,630	45,000	38,540	32,200	26,670	22,020	17,860	14,310	11,490	7310	4620
5	2½	61,320	54,350	47,370	40,560	33,900	28,080	23,180	18,800	15,060	12,090	7690	4860
5¼		64,380	57,070	49,730	42,600	35,600	29,480	24,340	19,740	15,820	12,700	8080	5110
5½	2¾	67,450	59,780	52,100	44,620	37,290	30,890	25,500	20,680	16,570	13,300	8460	5350
5¾		70,500	62,500	54,480	46,650	38,980	32,290	26,660	21,620	17,320	13,900	8840	5590
6	3	73,580	65,220	56,840	48,680	40,680	33,700	27,820	22,560	18,080	14,510	9230	5840
6¼		76,650	67,940	59,200	50,710	42,370	35,100	28,980	23,500	18,830	15,120	9610	6080
6½	3¼	79,700	70,650	61,580	52,740	44,070	36,500	30,140	24,440	19,580	15,720	10,000	6320
6¾		82,770	73,360	63,950	54,760	45,760	37,900	31,300	25,380	20,340	16,320	10,380	6570
7	3½	85,840	76,080	66,320	56,800	47,460	39,310	32,460	26,320	21,090	16,930	10,770	6810
7¼		88,900	78,800	68,680	58,820	49,150	40,720	33,620	27,260	21,840	17,530	11,150	7050
7½	3¾	91,970	81,520	71,050	60,850	50,850	42,120	34,770	28,200	22,600	18,140	11,540	7300
7¾		95,040	84,230	73,420	62,880	52,540	43,520	35,930	29,140	23,350	18,740	11,920	7540
8	4	98,100	86,950	75,790	64,900	54,240	44,930	37,100	30,080	24,100	19,350	12,300	7780
8¼		101,150	89,670	78,160	66,940	55,930	46,330	38,250	31,020	24,860	19,950	12,690	8030
8½	4¼	104,200	92,400	80,520	68,960	57,630	47,730	39,420	31,960	25,610	20,560	13,070	8270
8¾		107,300	95,100	82,900	71,000	59,320	49,140	40,570	32,900	26,360	21,160	13,460	8510
9	4½	110,350	97,820	85,260	73,020	61,020	50,540	41,730	33,840	27,120	21,770	13,840	8760
9¼		113,400	100,500	87,630	75,050	62,700	51,950	42,900	34,780	27,870	22,370	14,230	9000
9½	4¾	116,500	103,250	90,000	77,080	64,400	53,350	44,050	35,720	28,620	22,970	14,610	9240
9¾		119,550	106,000	92,360	79,100	66,100	54,760	45,210	36,660	29,370	23,580	15,000	9490
10	5	122,600	108,700	94,740	81,130	67,800	56,160	46,370	37,600	30,130	24,180	15,380	9730
10½	5¼	128,750	114,100	99,470	85,200	71,200	58,970	48,690	39,480	31,640	25,390	16,150	10,220
11	5½	134,900	119,550	104,200	89,250	74,580	61,780	51,000	41,360	33,140	26,600	16,920	10,700
11½	5¾	141,000	125,000	108,950	93,300	77,970	64,590	53,320	43,240	34,650	27,810	17,690	11,190
12	6	147,150	130,400	113,650	97,360	81,360	67,390	55,640	45,120	36,160	29,020	18,460	11,680
12½	6¼	153,300	135,850	118,400	101,400	84,750	70,200	57,960	47,000	37,660	30,230	19,230	12,160
13	6½	159,400	141,300	123,150	105,450	88,140	73,000	60,280	48,880	39,170	31,440	20,000	12,650
13½	6¾	165,500	146,750	127,900	109,500	91,530	75,820	62,600	50,760	40,680	32,650	20,760	13,140
14	7	171,700	152,150	132,600	113,600	94,920	78,620	64,920	52,640	42,180	33,860	21,530	13,620
14½	7¼	177,800	157,600	137,350	117,650	98,300	81,430	67,240	54,520	43,690	35,070	22,300	14,110
15	7½	183,900	163,000	142,100	121,700	101,700	84,240	69,560	56,400	45,200	36,280	23,070	14,600
15½	7¾	190,000	168,450	146,850	125,750	105,100	87,050	71,880	58,280	46,700	37,490	23,840	15,080
16	8	196,200	173,900	151,600	129,800	108,500	89,860	74,190	50,160	48,210	38,700	24,610	15,570
16½	8¼	202,300	179,350	156,350	133,850	111,850	92,670	76,510	62,040	49,720	39,910	25,380	16,050
17	8½	208,450	184,750	161,050	137,900	115,250	95,470	78,830	63,920	51,220	41,120	26,150	16,540
17½	8¾	214,600	190,200	165,800	142,000	118,650	98,280	81,150	65,800	52,730	42,330	26,920	17,080
18	9	220,700	195,650	170,500	146,000	122,050	101,100	83,460	67,680	54,240	43,540	27,690	17,510
18½	9¼	226,850	201,100	175,250	150,100	125,400	103,900	85,780	69,560	55,750	44,750	28,460	18,000
19	9½	233,000	206,500	180,000	154,150	128,800	106,700	88,100	71,440	57,250	45,960	29,230	18,490
19½	9¾	239,100	211,950	184,700	158,200	132,200	109,500	90,430	73,320	58,760	47,170	30,000	18,980
20	10	245,250	217,350	189,500	162,250	135,600	112,300	92.740	75,200	60,260	48,370	30,770	19,460

ranging from 80 per cent to 98 per cent in steps of 2 per cent, and for wires 3 ins. apart. The power factor is engraved on each diagram, and it is scarcely necessary to say that none of the diagrams is applicable for any power factor other than the one specified, or for wires any distance apart other than 3 ins., or any other frequency than 60 cycles. The scale at the bottom of each individual

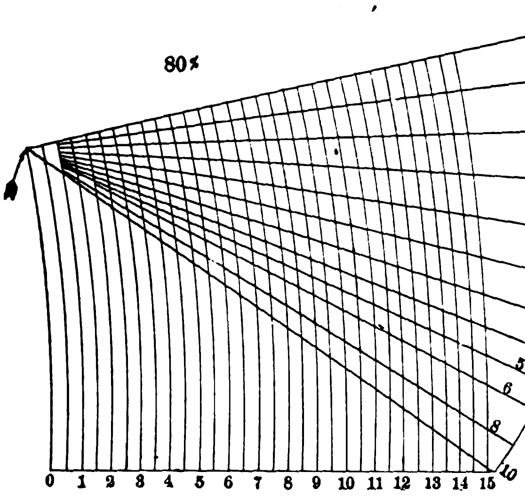


DIAGRAM FOR 80 PER CENT POWER FACTOR.

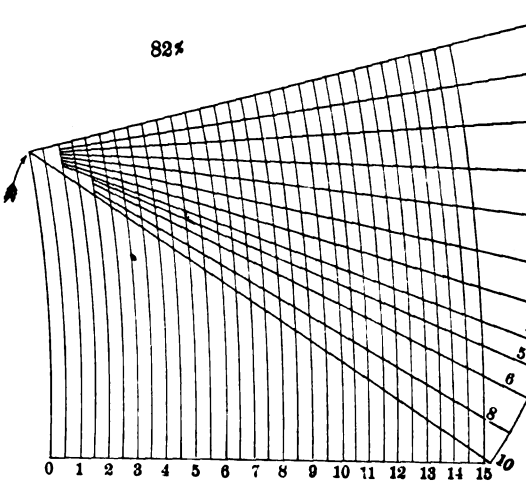
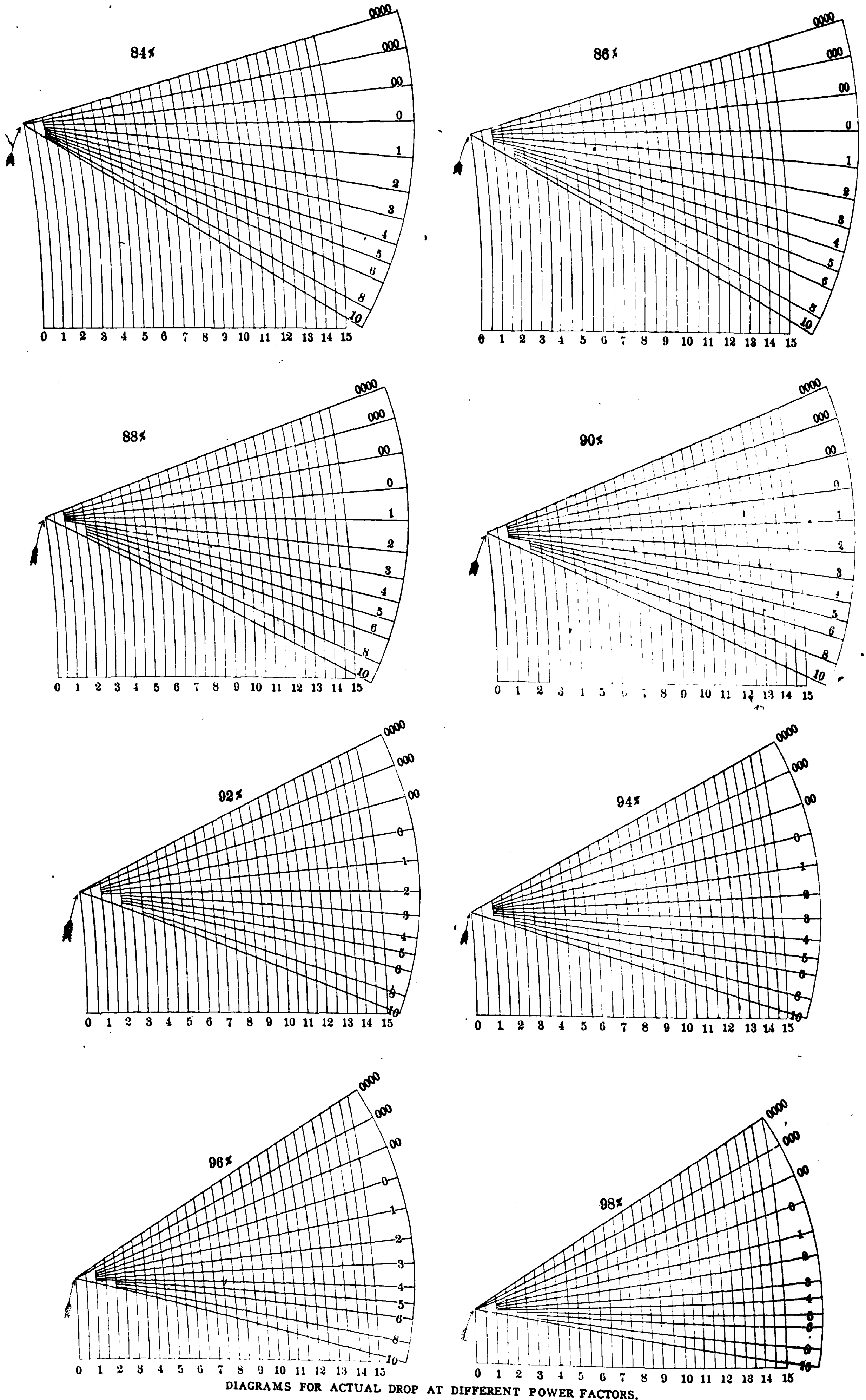


DIAGRAM FOR 82 PER CENT POWER FACTOR.

TABLE. II

For three-phase circuits with wires 3 ins. apart, and 60 cycles frequency. Figures in body of table are ampere-feet; *i.e.*, amperes per wire × distance in feet. Impedance drop is in percentage of motor e. m. f.

Impedance drop at		Wire Sizes; B. & S. Gauge.											
200 V.	400 V.	0000	000	00	0	1	2	3	4	5	6	8	10
1		14,160	12,550	10,940	9368	7830	6480	5352	4342	3480	2793	1776	1124
1¼		17,700	15,690	13,670	11,710	9780	8110	6693	5424	4349	3491	2220	1405
1½		21,240	18,830	16,410	14,050	11,740	9730	8031	6512	5220	4189	2665	1686
1¾		24,770	21,960	19,140	16,390	13,700	11,350	9370	7598	6089	4887	3109	1967
2	1	28,320	25,100	21,880	18,740	15,660	12,970	10,709	8684	6979	5583	3553	2247
2¼		31,860	28,240	24,610	21,080	17,610	14,590	12,048	9769	7829	6284	3997	2529
2½	1¼	35,390	31,380	27,350	23,420	19,570	16,210	13,385	10,852	8699	6982	4441	2810
2¾		38,940	34,510	30,080	25,760	21,520	17,830	14,725	11,940	9668	7680	4885	3090
3	1½	42,480	37,650	32,820	28,110	23,480	19,460	16,062	13,025	10,440	8379	5330	3371
3¼		46,020	40,790	35,550	30,450	25,440	21,080	17,408	14,110	11,308	9077	5734	3652
3½	1¾	49,550	43,930	38,290	32,790	27,400	22,700	18,740	15,196	12,177	9774	6218	3933
3¾		53,100	47,070	41,020	35,130	29,350	24,320	20,080	16,282	13,050	10,473	6662	4214
4	2	56,630	50,200	43,750	37,470	31,210	25,940	21,420	17,365	13,915	11,171	7106	4495
4¼		60,180	53,340	46,490	39,820	33,270	27,560	22,750	18,452	14,787	11,870	7550	4776
4½	2¼	63,710	56,480	49,220	42,160	35,220	29,180	24,090	19,536	15,656	12,567	7994	5057
4¾		67,250	59,620	51,960	44,500	37,180	30,810	25,430	20,623	16,525	13,265	8438	5338
5	2½	70,790	62,750	54,700	46,840	39,140	32,430	26,770	21,710	17,395	13,965	8882	5618
5¼		74,340	65,900	57,430	49,190	41,100	34,050	28,110	22,795	18,270	14,663	9328	5900
5½	2¾	77,870	69,030	60,160	51,530	43,050	35,670	29,450	23,880	19,135	15,360	9770	6181
5¾		81,410	72,170	62,900	53,870	45,010	37,290	30,790	24,965	20,005	16,057	10,215	6462
6	3	84,940	75,300	65,630	56,210	46,970	38,910	32,120	26,050	20,875	16,756	10,656	6742
6¼		88,500	78,440	68,370	58,560	48,920	40,530	33,460	27,135	21,745	17,455	11,105	7024
6½	3¼	92,030	81,480	71,100	60,900	50,880	42,150	34,800	28,230	22,615	18,153	11,546	7304
6¾		95,570	84,720	73,830	63,240	52,840	43,770	36,140	29,305	23,485	18,850	11,990	7585
7	3½	99,110	87,850	76,570	65,580	54,800	45,400	37,480	30,390	24,355	19,550	12,435	7866
7¼		102,650	91,000	79,300	67,920	56,750	47,010	38,820	31,480	25,225	20,250	12,880	8148
7½	3¾	106,200	94,130	82,040	70,260	58,710	48,640	40,160	32,562	26,095	20,945	13,325	8430
7¾		109,730	97,260	84,780	72,600	60,670	50,260	41,500	33,650	26,975	21,643	13,765	8710
8	4	113,270	100,400	87,500	74,950	62,620	51,880	42,830	34,731	27,835	22,340	14,210	8990
8¼		116,800	103,550	90,250	77,300	64,580	53,500	44,170	35,840	28,705	23,040	14,655	9271
8½	4¼	120,350	106,680	92,980	79,630	66,540	55,120	45,510	36,905	29,575	23,740	15,100	9542
8¾		123,900	109,820	95,720	81,980	68,500	56,740	46,850	37,990	30,445	24,435	15,545	9833
9	4½	127,420	112,960	98,440	84,320	70,450	58,360	48,190	39,075	31,315	25,135	15,990	10,114
9¼		130,970	116,100	101,880	86,660	72,410	59,990	49,530	40,160	32,185	25,835	16,440	10,395
9½	4¾	134,500	119,230	103,920	89,000	74,360	61,610	50,870	41,245	33,051	26,530	16,875	10,675
9¾		138,020	122,360	106,650	91,340	76,320	63,230	52,200	42,330	33,925	27,230	17,320	10,956
10	5	141,600	125,500	109,380	93,680	78,280	64,850	53,540	43,420	34,800	27,930	17,760	11,240
10½	5¼	148,650	131,800	114,850	98,380	82,200	68,100	56,220	45,590	36,535	29,325	18,650	11,800
11	5½	155,730	138,050	120,320	103,050	86,100	71,340	58,900	47,760	38,270	30,720	19,540	12,360
11½	5¾	162,800	144,320	125,800	107,740	90,020	74,580	61,580	49,930	40,010	32,120	20,430	12,925
12	6	169,900	150,600	131,250	112,430	93,930	77,820	64,250	52,100	41,750	33,510	21,315	13,485
12½	6¼	177,000	156,880	136,720	117,120	97,840	81,070	66,930	54,275	43,490	34,910	22,205	14,050
13	6½	184,050	163,150	142,200	121,800	101,850	84,300	69,600	56,440	45,230	36,310	23,090	14,610
13½	6¾	191,150	169,420	147,660	126,460	105,680	87,550	72,280	58,620	46,970	37,700	23,980	15,170
14	7	198,210	175,700	153,120	131,150	109,590	90,800	74,960	60,780	48,710	39,100	24,860	15,730
14½	7¼	205,300	182,000	158,600	135,850	113,500	93,380	77,640	62,950	50,450	40,500	25,760	16,295
15	7½	212,380	188,260	164,080	140,520	117,420	97,280	80,310	65,125	52,190	41,890	26,650	16,855
15½	7¾	219,450	194,520	169,520	145,210	121,330	100,510	82,990	67,300	53,925	43,290	27,530	17,420
16	8	226,520	200,800	175,000	149,900	125,250	103,760	85,680	69,475	55,675	44,685	28,420	17,980
16½	8¼	233,600	207,100	180,500	154,600	129,150	107,000	88,340	71,640	57,410	46,080	29,310	18,542
17	8½	240,700	213,350	185,950	159,250	133,080	110,250	91,020	73,810	59,125	47,470	30,200	19,101
17½	8¾	247,750	219,630	191,430	163,950	137,000	113,500	93,700	75,980	60,900	48,870	31,090	19,665
18	9	254,850	225,900	196,900	168,620	140,900	116,720	96,380	78,150	62,625	50,275	31,980	20,230
18½	9¼	261,920	232,200	202,370	173,330	144,820	120,000	99,060	80,320	64,375	51,675	32,875	20,790
19	9½	269,000	238,450	207,820	178,000	148,720	123,200	101,730	82,500	66,110	53,060	33,750	21,350
19½	9¾	276,090	244,720	213,300	182,700	152,630	126,460	104,400	84,675	67,850	54,460	34,640	21,915
20	10	283,170	251,000	218,780	187,380	156,550	129,700	107,080	86,840	69,590	55,860	35,530	22,465



DIAGRAMS FOR ACTUAL DROP AT DIFFERENT POWER FACTORS.

diagram refers to the actual drop in percentage of the e.m.f. at the motor. The use of the table and diagrams may be illustrated as follows:

Assume that a 200-volt two-phase motor with a power factor of 92 per cent and requiring a current of 24 amperes per wire is installed 50 ft. from the transformer or the secondary supply main, measured as the wires run, and that the wires are 3 ins. apart throughout their length. The ampere-feet of the lead wires will be 24 x 50 = 1200 ampere-feet. Assuming that it is desired to limit the drop to 5 per cent, a size of wire should be chosen tentatively which will give, according to the table, an impedance drop of this value. Referring to the section of the table applying to wires 3 ins. apart, the nearest value to 1200 ampere-feet in the 5 per cent line is 1209, and at the head of the column in which this number occurs is the preliminary size of wire, which is No. 6. Now, referring to the diagram for a power factor of 92 per cent, take a pair of dividers and set them by the scale below the diagram for 5 per cent drop. Then put one leg of the dividers at the point indicated by the arrow, and set the other point on the line corresponding to No. 6 wire. This point will be found to rest a little beyond one of the circular arcs which cut across the lines corresponding to the wire sizes, and following this position down to the scale below the diagram, the actual drop is found to be 4½ per cent full. This is sufficiently near the desired drop to justify the use of No. 6 wire, as indicated by the table, but in many cases the actual drop will be found to be so much lower than the impedance drop given by the table that a smaller size of wire can be used. For example, if the power factor in the case assumed had been 82 per cent instead of 92 per cent, the actual drop would have been a trifle under 4 per cent, and No. 7 wire might have been used.

This method of determining wire sizes requires at most only two trials. If it should develop upon the first trial that the size of wire indicated by the impedance table gives a much smaller actual drop than necessary, the next smaller size wire will almost invariably be found to come sufficiently close to the actual drop desired. It should be remembered that neither the impedance drop given by the table nor the actual drop given by the diagrams indicates the real *loss* in the lead wires. This is found, of course, by calculating the drop exactly as for direct current.

The method here described will be recognized by most of our readers as a modification of the chart method originated by Mr. Ralph D. Mershon and published in this paper several years ago. The present method, however, has the advantage that no calculation is necessary except the multiplication of the current per wire by the distance in feet.

Wireless Telegraphy to Block Island.—It is reported that a wireless telegraph system will be operated between Providence and Block Island, R. I., and that negotiations have been entered into for the purpose by the American Marconi Company.

A MERCURY INTERRUPTER.

BY WM. A. DEL MAR.

Induction coils taking a large primary current require considerable area of metal at the contacts of the interrupter. For this reason large coils are often supplied with mercury interrupters instead of with the old form of vibrator having platinum contacts. A great number of more or less complicated forms of this apparatus have been devised, many of which require a special mechanism to operate them, but they are generally lacking in portability and simplicity. A simple and portable form of interrupter actuated, like the common vibrator, by the magnetism of the core, is here described and illustrated.

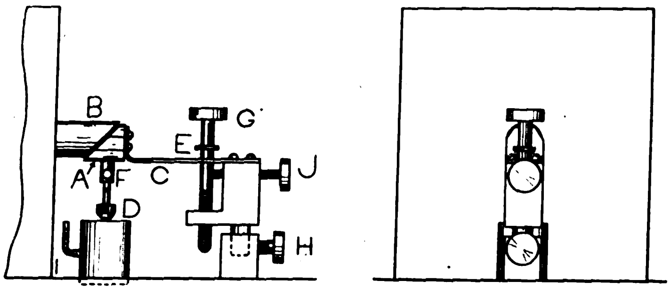


FIG. 1.—MERCURY INTERRUPTER.

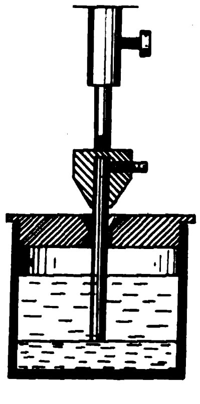


FIG. 2.

The moving part consists of the soft-iron half prism, *A*, Fig. 1, the spring, *C*, and contact attachments, *F*, *D*. The core, *B*, of the induction coil is filed away to an angle of 45° to match the end of the half prism of iron. The screw, *G*, with its collar, *E*, is for adjusting the tension of the spring, and the screw, *J*, is to clamp the screw, *G*, at any desired point. The elevation of this whole system can be adjusted by means of the pin, socket and screw at *H*.

The socket, *F*, which is soldered to the iron, holds a short rod of copper, which terminates in a small cone, *D*. Fastened into this cone by a small screw, is a thick iron wire, which extends into a hollow iron cylinder containing mercury. All these parts are shown in section to a larger scale, in Fig. 2. The lid of the iron vessel is made of hard fibre, and has a central hole which is countersunk, as though for the head of an ordinary wood screw. When the moving system is lowered by means of the screw, *G*, or the socket and screw, *H* (Fig. 1), the cone, *D*, fits into this hole and entirely closes it, thus preventing evaporation and spilling of fluid when the apparatus is not in use.

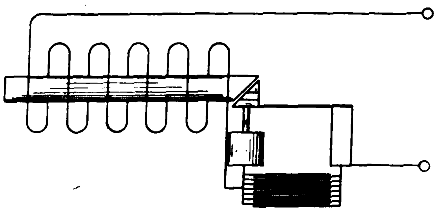


FIG. 3.—DIAGRAM OF CONNECTIONS.

The iron vessel contains not only mercury, but also from ½ to ¾ inch of pure alcohol, which prevents oxidation of the mercury and iron, and causes a sharper spark than can be obtained in air. This vessel fits into a slight recess in the base of the induction coil, and may be provided with a glass level gauge, to indicate the amount of alcohol. The depth of alcohol over the spark should never be less than one-half inch, or there will be danger of fire.

For small coils, the rod *F D* may be dispensed with, and the bottom of the socket, *F*, made into a cone. In that case the iron wire is fastened directly into the socket *F*.

The action is exactly the same as that of the ordinary platinum contact interrupter. A diagram of the circuit is shown in Fig 3. For ease of adjustment and constancy of action, this interrupter is hard to excel.

Lessons in Practical Electricity

THE DRUM ARMATURE.

The form of armature illustrated by Fig. 1 (reprinted from the last Lesson) is known as the "drum" armature," on account of the shape of the core, but the appropriateness of the name ends with the outside appearance of the core, because it is not hollow, except in large machines. In modern practice, the coils of a drum armature are evenly distributed over the entire periphery of the core, instead of being bunched at intervals, as in Fig. 1. Furthermore, the number of coils is much greater than four, ranging from twelve in very, very small machines, up to several hundred in large machines. Fig. 2 is a diagram of a drum armature winding, in which the number of coils is restricted to 16 and the turns per coil to one, for simplicity.

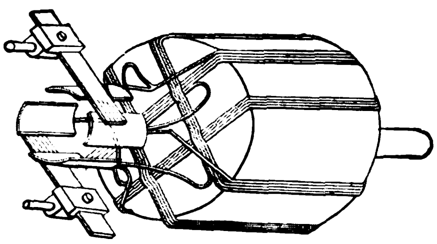


FIG. 1.

The brushes are represented by the solid black blocks, *A* and *B*, located on the inside of the commutator in order to avoid obscuring the winding. In this diagram, the coils are disposed in two layers, which arrangement is almost exclusively used nowadays. When coils of several turns are used, there are several layers of *wire*, but usually only two layers of *coils*. These are nearly always overlapped so that one side of each coil is next to the core and the other side outside, as indicated in Fig. 3, which shows coils Nos. 8 and 16 of the winding in Fig. 2. In the latter engraving, the two sides of each coil are numbered alike, for identification; the wires are carried across the back-head of the core in some such fashion as indicated by the dotted lines *8* and *16* in Fig. 3.

Assuming the armature to rotate clockwise, the direction in which current will flow in the winding when the outside circuit is closed is indicated by the arrow-heads on the leads to the commutator, and a comparison with the fundamental diagram, Fig. 4 (repeated from last month), will show that the flow in each wire on the surface of the drum corresponds with the latter diagram. And by tracing from the brush *B* through the winding to brush *A*, it will be found that there are two paths in parallel, and that the direction of current flow in all the wires of each branch is the same; which is, of course, necessary for the machine to be operative.

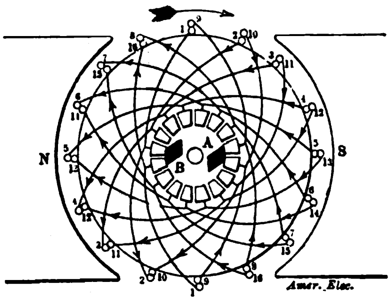


FIG. 2.

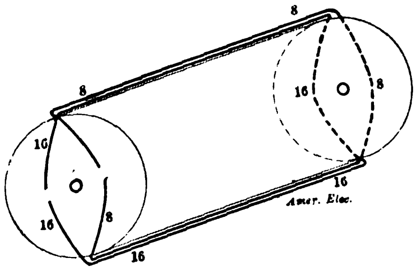


FIG. 3.

This is shown more graphically in Fig. 5, where the armature coils are represented as rectangular loops grouped in a circle about the commutator without reference to the core drum or the magnet, the object being merely to show the result of Fig. 2 as to current flow through the winding. The under sides of the coils, or the sides next to the core in Fig. 2 are indicated by the letters *b, b,* etc., and the top sides by *t, t,* etc.; the coils are numbered as in Fig. 2, but the geometrical relationship between them is, of course, upset, only the electrical relationship being preserved.

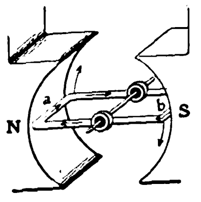


FIG. 4.

It will be observed that two of the coils, Nos. 1 and 9, are shown short-circuited by the brushes. This is necessary in order that the commutator segments to which they are connected may pass the brushes without opening the circuit. As indicated by Fig. 2 and previously explained, this short-circuit occurs when the coil is generating little or no e.m.f., so that it causes no damage to the coil.

The result of the connections shown is that eight of the coils are in series in one branch and eight in the other (the short-circuit being momentary), and upon analysis it will be found that precisely the same total e.m.f. is generated in each branch. Thus, coil 2 and coil 10 are in exactly the same position, so that whatever e.m.f. is generated in one will be generated in the other; and one is in one branch (see Fig. 5), while the other is in the other branch. The same is true of every pair of coils lying in one radial plane, Nos. 3 and 11, Nos. 6 and 14, and so on. Consequently, the aggregate e.m.f. of coils 1 to 8 must be the same as that of coils 9 to 16, and the two aggregates oppose each other within the winding, just as two hydraulic pressures would if water were confined in two curved pipes, as in Fig. 6, with a cylinder and piston in each pipe to give pressures corresponding to the e.m.fs. in each branch of the armature winding. It is obvious that if the tees *A, B,* in Fig. 6 were connected by a pipe, as indicated by the dotted line, and clack valves were put in the pistons, the movement of the latter would cause a flow of water from *A* to *B* through the curved pipes and back to *A* through the straight pipe.

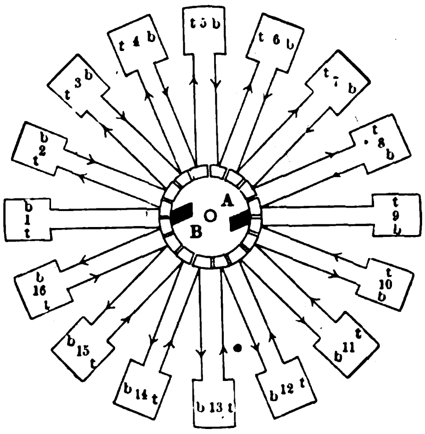


FIG. 5.

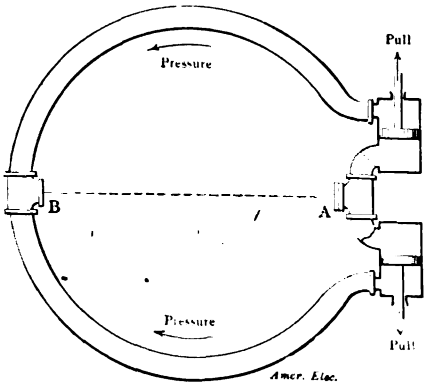


FIG. 6.

This is almost a precise analogue to the action in the armature winding. As long as the brushes are not connected electrically there will be electrical pressure (e.m.f.) generated by the cutting of lines of force by the wires of the winding, but no current can flow until an exterior circuit from brush to brush is added. The analogue is imperfect in that all the pressure is generated at one end of the circuit in the hydraulic illustration.

As explained in the preceding Lesson, the e.m.f. generated in each wire rises and falls in strength during each half revolution. When a large number of coils is used, the variations in the individual wires compensate each other so that the aggregate e.m.f. of each complete half of the winding is steady. For example, if the magnetic field were 200,000 lines of force and the speed of the armature were 25 revolutions a second, the actual number of lines of force, rate of cutting per second and e.m.f. generated in one-half of the armature winding during one-sixteenth of a revolution, taken from the position shown in Fig. 2 to that shown in Fig. 7, would be as follows:

Each wire Coil No.	Cuts	Rate of cutting, each wire	E.m.f. in each wire	E.m.f. in each coil
1	7,602 lines	3,040,800	.030408	.060816
2	21,677 "	8,670,800	.086708	.173416
3	32,453 "	12,981,200	.129812	.259624
4	38,268 "	15,307,200	.153072	.306144
5	38,268 "	15,307,200	.153072	.306144
6	32,453 "	12,981,200	.129812	.259624
7	21,677 "	8,670,800	.086708	.173416
8	7,602 "	3,040,800	.030408	.060816

Total lines..200,000.
Total e.m.f.....1.6 volts.

The rate of cutting for each wire is 400 times the number of lines cut, because these are cut in one-sixteenth of a revolution, which is accomplished in 1/400 of a second, and the e.m.f. per coil is twice the e.m.f. per wire because there are two active wires per coil. During the next sixteenth of a revolution the result is precisely the same as to the total e.m.f., because each coil simply takes the position that was occupied by the one ahead of it in the step just considered. At the next step, coil No. 16 is transferred from the right-hand branch to the left-hand branch, and coil No. 1 is transferred to the right-hand branch, as Fig. 8 shows; similarly, the succeeding step transfers coils 2 and 15 from one branch to the other, and so on. The transference and e.m.fs. generated during a revolution in the left-hand branch (Fig. 2) are as below:

COILS IN THE LEFT-HAND BRANCH.

E.M.FS......	.060816	.173416	.259624	.306144	.306144	.259624	.173416	.060816
Step a; Coils....	1	2	3	4	5	6	7	8
" b; "	16	1	2	3	4	5	6	7
" c; "	15	16	1	2	3	4	5	6
" d; "	14	15	16	1	2	3	4	5
" e; "	13	14	15	16	1	2	3	4
" f; "	12	13	14	15	16	1	2	3
" g; "	11	12	13	14	15	16	1	2
" h; "	10	11	12	13	14	15	16	1
" i; "	9	10	11	12	13	14	15	16
" j; "	8	9	10	11	12	13	14	15
" k; "	7	8	9	10	11	12	13	14
" l; "	6	7	8	9	10	11	12	13
" m; "	5	6	7	8	9	10	11	12
" n; "	4	5	6	7	8	9	10	11
" p; "	3	4	5	6	7	8	9	10
" q; "	2	3	4	5	6	7	8	9

By "Step a" is meant the travel from the position of Fig. 2 to that of Fig 7; "Step b" is the travel through the next sixteenth of a revolution, to the position of Fig. 8, and so on. The e.m.fs. at the top of the table are those generated in the coils of the numbers beneath them. Thus, coil No. 1 generates 0.060816 volt during "step a," 0.173416 volt during "step b," and so on. It will be plain that the total e.m.f. generated by all the coils of each branch of the winding remains 1.6 volts throughout the revolution, notwithstanding the variation of e.m.f. in each coil.

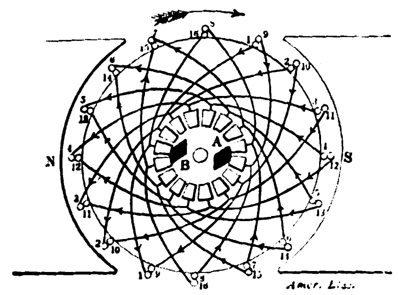


FIG. 7.

It follows from this demonstration that the e.m.f. generated in any drum armature revolving between two magnet poles and having a winding of the type here shown will be given by the formula

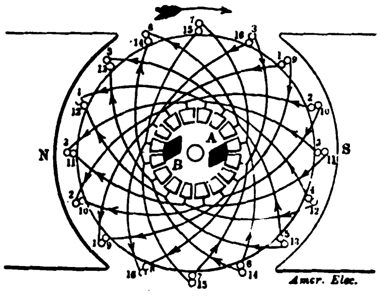


FIG. 8.

$$\frac{\Phi \times Nw \times r.p.s.}{100,000,000} = E \ldots\ldots (1)$$

in which Φ is the number of magnetic lines of force passing through the armature; *Nw* is the number of wires around the periphery of the armature and *r.p.s.* is the speed in revolutions per second. In the case just assumed, the magnetic flux, Φ, was 200,000; the number of wires, 32 (16 coils of two wires each), and the revolutions per second, 25. Substituting these values in the formula:

$$\frac{200,000 \times 32 \times 25}{100,000,000} = 1.6,$$

which has been shown to be the e.m.f. generated in each of the two parallel branches of the winding, and therefore the e.m.f. at the brushes. Formula 1 applies to all armature windings in which the number of branches in the winding is equal to the number of magnet poles on the machine.

Letters on Practical Subjects

Electric Blindness.

To the Editor, American Electrician—

The writer recently had a bad siege of electric blindness, or eye burn, from peering into a small electric furnace, and submits his experience in the hope that it may benefit others. This trouble is not strictly a blindness, but that is the name usually given to the effect on the eyes produced by overexposure of them to the hot glare of an electric arc. The eyes do not burn or pain at the time of exposure to the arc, but become very painful two or three hours afterward. Eyes so affected are very red, and have small white spots in them. I am informed that in many cases permanent injury is sustained, so that one cannot be too careful in exposing the eyes to this powerful heat. As soon as any pain is experienced from this cause the eyes should be bathed twice a day in cold water, from 1½ to 2 hours each time, and one drop of the remedy specified in the accompanying prescription should be put in each eye every three hours; the cold water baths should be timed so as to come midway between two applications of the eye drops:

PRESCRIPTION FOR EYE DROPS.

Holocain Muriatic, 1/100	*3 grams*
Adrenalin Chloride, 1/1000	*3 grams*
Distilled Water	*4 cu. cm.*

The patient should remain indoors and wear very dark glasses until the eyes are entirely restored to their normal condition, and direct exposure to any light should be carefully avoided.

HOWARD F. SHEPHERD.

Colorado Springs, Col.

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Mr. Chase's Problem in Telephone Connections.

To the Editor, American Electrician:—

The enclosed diagram is my solution of Mr. A. T. Chase's problem in the May number of the AMERICAN ELECTRICIAN. An ordinary two-point switch is provided at Stations *A* and *B* in addition to the existing apparatus. The switch at *A* rests normally on the button *c*, and the switch at *B* rests normally on the left-hand button, as shown in the diagram. With the switches in these positions Station *A* can call Station *C*, or *vice versa*. If Station *A* wishes to call Station *B*, the switch is thrown to the button *b*, and after the conversation it is returned to the button *c*. If Station *B* wishes to call Station *A* the switch at Station *B* is thrown to the right, which obviously connects the two stations. The gas pipe is used for a common return for all three stations.

Charlotte, N. C. GLENN BASKERVILLE.

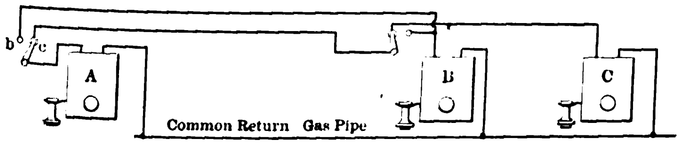
To the Editor, American Electrician:—

Enclosed please find a diagram fulfilling the requirements of Mr. A. T. Chase's telephone problem published in the May number. An extension bell, *E*, and a four-pole double-throw switch are provided at Station *A* in addition to the original telephone outfit, and all three stations are connected to the gas pipe for common return. The upper jaws *1* and *2* of the double-throw switch are cross-connected to the lower jaws of the same number. This is true also of the upper jaws *3* and *4* and the lower jaws of the same numbers, cross-connections being omitted for simplicity. It will be evident upon tracing the connections that when the switch-handle is thrown up Station *A* can call Station *B*, and when it is thrown down Station *C* can be called. With the switch in either position, the extension bell can be rung by the station which is connected for talking, and the regular bell can be rung by the other stations; consequently, no matter which position the switch is in, if the regular bell rings the switch must be thrown to the opposite position for talking, and if the extension bell rings it need not be disturbed.

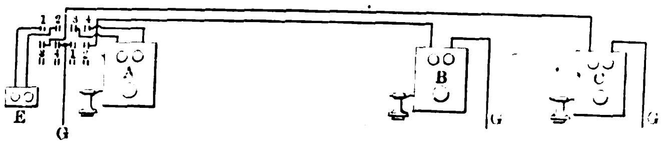
Ithaca, N. Y. F. C. GOBEL.

To the Editor, American Electrician:—

Mr. A. T. Chase's problem in telephone connections, which appeared in your May number, is not stated very clearly. Mr. Chase omits to explain whether the signaling apparatus is of the magneto type, or whether the batteries are also used to ring vibrating bells, and also whether privacy is desired as to Stations *B* and *C*. Assuming that the existing instruments are provided with magneto-signaling apparatus, the enclosed diagram furnishes one solution to Mr. Chase's problem. The diagram shows a vibrating bell connected between the line wire *b* and the gas pipe at Station *A*, together with a double-pole, double-throw switch, which connects the battery to the telephone set when thrown to the left and to line wire *b* and the gas pipe when thrown to the right. The telephone set at Station *C* is provided with a vibrating bell which responds when the battery switch at *A* is thrown to the right. The bell at *A* also rings, and as it is in parallel with the one at Station *C*, it should be of moderately high resistance. At Station *C*, a double-pole push or switch, according to the user's fancy, is employed, which when depressed connects the transmitter battery between the line wire *b* and the gas pipe, thus ringing the vibrating bell at Station *A*. As Mr. Chase did not state that privacy was required as between Stations *B* and *C*, the



MR. BASKERVILLE'S SOLUTION.



MR. GOBEL'S SOLUTION.

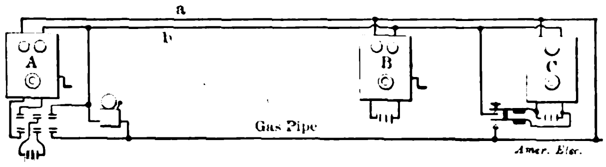
line wires *a* and *b* are used for talking by all three stations, the gas pipe being used only for signaling between Station *A* and Station *C*. The double-throw switch at Station *A* is kept normally thrown to the left, of course, being thrown to the right momentarily only when it is desired to signal Station *C*.

Brooklyn, N. Y. Geo. W. Malcolm.

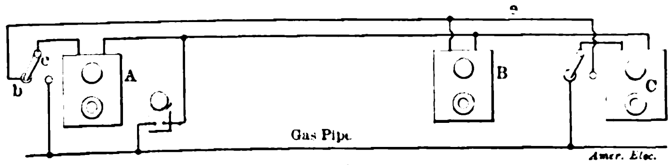
To the Editor, American Electrician:—

The enclosed diagram shows a method of fulfilling the requirements of Mr. Chase's problem, published last month. A two-way single-pole switch and an auxiliary vibrating bell are provided at Station *A*, and a two-way switch at Station *C*, in addition to the telephones. The switch at Station *A* always rests on the button *b*, except when it is desired to call up Station *C*, in which case the switch is moved over to the button *c*, and the signaling push button on the instrument case depressed in the usual manner, after which the switch is returned to the button *b* for talking. All three of the stations use the line wires for talking, the gas pipe being only used to signal between Stations *A* and *C*. When Station *C* has been called up by Station *A* the switch at Station *C* is thrown to the right for talking. When Station *C* desires to call Station *A* the user proceeds in the ordinary manner without disturbing the switch; but, after calling, the switch is thrown to the right for talking. If the gas pipe affords sufficient conductivity and is not subject to inductive influences, the switch at Station *C* and the extension, *e*, of the upper line wire may be omitted, and the outfit at Station *C* connected permanently to the gas pipe. In this case a double-pole switch will have to be provided at Station *A*, one blade of which would perform the function of the switch shown, the other blade serving to disconnect the vibrating bell when the switch was thrown to the right. The switch would be put in the right-hand position, both for signaling and talking between Station *A* and Station *C*. The writer's preference, however, is for the arrangement shown in the diagram.

Baltimore, Md. K. M. Perry.



MR. MALCOLM'S SOLUTION.



MR. PERRY'S SOLUTION.

New Power Project in California. — It is proposed to install an electric transmission plant in Plumas County, Cal., whence current will be transmitted 180 miles to San Francisco. A vertical fall of 1600 ft. will be provided at a point on Mosquito Creek, giving an estimated total of 270,000 horse-power.

Electrical Catechism

678. What is meant by electro-etching?

It is known that the anodes employed in electrolytic processes become dissolved in the bath during electrodeposition, and it is evident that if certain portions of the anode were protected by means of a suitable varnish from the solvent action of the solution, that such parts, after the plate has been subjected to electro-chemical action in the bath, would appear in relief on the removal of the varnish, owing to the exposed surface having been reduced in substance by being partially dissolved in the solution. This process is electro-etching.

679. How is the etching performed?

The process is performed in various ways, but the general principle may be explained as follows: A copper wire is first soldered to a bright copper plate and the back is then coated with a tough varnish; when this is dry, the face of the plate is coated with engraver's "etching ground," a composition of beeswax and linseed oil. It is sometimes the practice to smoke the surface before applying the etching needle in order to render the tracing more visible. The design is then drawn upon the face of the plate, cutting through to the clean surface of the copper. When the drawing is complete, the plate is made the anode in a sulphate of copper bath, while a plate of copper is immersed as the cathode. The electric current passing out of the parts of the plate exposed by the drawn lines, causes the copper to be dissolved, whereby the lines become etched much in the same way as when acid is used in the ordinary etching processes. The various gradations of light and shade are produced by suspending cathodes of different forms and sizes opposite the plate to be etched in various positions and at different distances from it, thus causing the plate to be eaten to unequal depths in different parts, the deepest action being always at those portions of the electrodes which are nearest together.

680. What baths should be used for etching by electrolysis?

The bath used should be a solution of the same metal as that to be etched; thus, a sulphate of copper bath is employed for etching copper plates, sulphate of zinc is employed for etching zinc plates, and gold and silver solutions, when their metals are to be treated in the same way. Copper and zinc plates, however, may be etched also in dilute solutions of nitric, sulphuric, hydrochloric or acetic acids.

681. What is a good copper plating solution?

Twenty parts of crystallized acetate of copper are reduced to a powder and formed into a paste with water; to this are added twenty parts of soda crystals dissolved in 200 parts of water, the mixture being well stirred. To the green precipitate thus formed twenty parts of bisulphite of sodium, dissolved in 200 parts of water, are added, by which the precipitate acquires a dirty green color. Twenty parts of pure cyanide of potassium dissolved in 600 parts of water are finally added and the whole well stirred together. If the solution does not become colorless, an addition of cyanide must be given. The solution may be worked hot or cold with a moderately strong current.

682. What solutions are used for metals which are attacked by copper sulphate?

The deposit of copper on iron or any other metal which is attacked by copper sulphate is effected by an alkaline solution. One which may be worked cold is made by dissolving copper sulphate in water, and adding to the solution a quantity of ammonia until the first formed precipitate has redissolved and formed a deep blue solution; then add cyanide of potassium until the blue color disappears. A heavy current is required with this solution, which deposits at a high rate, but ordinarily leaves a rough and crystalline surface, and will not do good work on steel.

683. What solutions are used on steel?

A cyanide solution which takes well on steel, and is also used for brass and iron, is made by dissolving in a gallon of water five ounces of copper carbonate, two ounces of potassium carbonate and ten ounces of chemically pure potassium cyanide. Nine-tenths of the potassium cyanide is dissolved in a portion of the water, and almost all of the copper carbonate is then added, having been previously dissolved in another portion of the water. Dissolve the carbonate of potash in the remaining water and add it gradually to the above solution, stirring it slowly until the whole is thoroughly mixed. The solution should be tested with a small object, and copper of cyanide added until the deposit is uniform and strong.

684. What is electrolytic copper?

Copper which has been deposited by the action of the electric current, as in electroplating work.

685. How is this process carried on?

The crude copper obtained from the smelting furnaces is cast or rolled in the form of plates, and these are used an anodes in electrolytic cells. The electrolyte is a solution of copper sulphate, acidulated with sulphuric acid to increase its conductivity. The cathodes are usually thin sheets of pure copper upon which the refined copper is deposited. The impurities are left behind in the anode or in solution in the electrolyte, or as a scum or sediment.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Can a storage battery be made of lead and copper in a sulphuric acid solution? T. S.

Yes, but the results will be very poor. Almost any primary battery is a storage battery in this sense.

In bringing a large reversing engine to a standstill is it good practice to reverse the engine with the throttle open in order to hasten the stop? H. C. L.

No; this should not be done except in extreme cases. The best plan is to shut the throttle and then throw over the reversing lever, utilizing the compression in the cylinder to facilitate the stopping.

If a shunt-wound dynamo is short-circuited at the brushes, which would burn out, the armature or the field coils? (2) In what case would the field coils be burned? C. J. D.

If anything burned it would be the armature coils, but with some machines the external characteristic is such that short-circuiting kills the field before the armature is damaged. (2) The shunt-field winding could not be damaged by short-circuiting at the brushes under any conditions.

Why is an induction coil capable of giving an 8 or 10-in. spark used in connection with wireless telegraphy when the air-gap is reduced to a fraction of an inch? C. G. S.

For two reasons; first, because the condenser action of the aerial wire requires a high voltage, and secondly because a ¼-in. or ½-in. spark cannot be started instantaneously by a coil the maximum capacity of which is a spark of that length. For example, a coil having a maximum spark capacity of ½-in. will not start with a spark-gap ½-in. long, but requires that the gap be reduced to about $^1/_{32}$ of an inch and gradually lengthened. In wireless telegraph operation the spark must leap instantaneously across a stationary spark-gap when the key is closed.

In the description of the 75-light dynamo published in the issue of January, 1901, it is stated that the number of armature slots is 40 and that the number of coils is 41; as the number of coils and the number of slots must be the same in the form of winding described, one of these statements must be wrong; which is correct? B. M.

The correct number of slots is 41; the figure 40 was a typographical error.

What is the formula for calculating the drop in a two-phase circuit supplying a non-inductive load? C. B. H.

$$E \times \sqrt{\left(1 + \frac{IR}{E}\right)^2 + \left(\frac{IX}{E}\right)^2} - E = V$$

in which E is the e.m.f. at the load, I is the current per wire, R is the resistance of a two-wire circuit of the same length, X is the reactance of a two-wire circuit of the same length, and V is the drop in volts.

[This query and answer appeared last month, but a misprint caused the query to read "three-phase" instead of "two-phase."—ED.]

Would a change in the resistance of the secondary winding of a transformer affect the primary current? (2) Would the energy expended in the primary winding be the same if the secondary winding and connections were absent? C. V. R.

Not unless the change in the secondary resistance affected the secondary current. (2) The energy expended in the primary with the secondary circuit open is precisely the same as the energy that would be expended in the primary if the secondary winding were removed, but this is not the same as the expenditure of energy in the primary winding when the secondary circuit is closed. In the latter case the strength of current in the secondary winding determines the strength of current in the primary winding, and consequently the I^2R loss in the primary. The iron losses are practically the same in both cases.

What is the formula giving the relation between pressure and temperature of saturated steam? (2) How is the latent heat of evaporation calculated? W. R. D.

The formula for pressure at a given temperature is:

$$Log\,P = 6.1 - \frac{2731.62}{t} - \frac{396944}{t^2}$$

in which P is the absolute pressure in pounds per square inch, and t is the temperature in Fahrenheit degrees. The formula for temperature at a given pressure is as follows:

$$t = \frac{1}{\sqrt{\frac{6.1 - log\,P}{396944} + 0.00001184} - 0.003441} - 461.2$$

in which E is the e.m.f. at the load, I is the ing as above. (2) The formula for the latent heat of evaporation at a fixed pressure is:

$$L = 1091.7 - 0.695\ (t - 32) - 0.000000103\ (t - 39.1)^2,$$

in which t is the Fahrenheit temperature. In practical calculations the third term is usually omitted, leaving the formula

$$L = 1091.7 - 0.695\ (t - 32),$$

or

$$L = 1113.94 - 0.695t.$$

What is the difference between a rotary converter and a double-current machine? G. A. C.

Structurally there is substantially none. If a rotary converter be provided with a pulley and driven from a suitable source of power, it will operate as a double-current generator, supplying both direct and alternating current.

Does any current flow in the armature conductors of a squirrel-cage induction motor after the machine has reached synchronism? J. R. N.

The rotor of an induction motor never reaches synchronism. It is necessary that the speed should be something less than synchronism in order for the current to flow through the conductors. If the machine were driven by some outside source precisely at synchronism there would be no current in the rotor conductors.

Can a compound-wound Edison bipolar dynamo be operated as a motor by cutting out the compound winding? (2) Will this cause any greater stress on the insulation of the shunt fields or endanger them in any way? G. V.

Yes. (2) No.

Why do grounded telephone lines work better at one time than another? M. R. C.

Because of the different conditions of the earth. After a rain or in warm weather the conductivity of the contact between the ground plate and the earth is better than when the earth is dry or frozen.

What is the advantage of the fourth wire in a four-wire three-phase system? (2) What is the relation between the voltage from the fourth wire to the each of the outer wires and the voltage between any two of the outer wires? J. S.

The four-wire system reduces the amount of copper required for a given load and admits a greater amount of unbalancing for a given degree of regulation. (2) The voltage between any two of the main wires is 1.732 times the voltage from the neutral wire to any one of the main wires.

Why is the series-parallel method of car control more economical at low speeds than the old rheostat control? (2) Why is it that an arc-light dynamo may be short-circuited without damage, while an incandescent machine is almost sure to be burned out? A. E. T.

Because the machines are operated at half speed by connecting them in series without using any idle resistance. (2) Because an arc-light machine is built to give a constant current regardless of variations in the resistance of the circuit, while the current delivered by a constant-potential machine increases directly as the resistance of the circuit decreases.

How can the loss due to friction of water against the sides of a pipe be determined? S. T. L.

It is not necessary to determine the friction loss independently. A convenient formula for ascertaining the quantity of water that may be delivered to a pipe by a given pressure is the following:

$$Q = \sqrt{\frac{P\,d^5}{107\,L}}$$

in which Q is the number of cubic feet of water per second, P is the applied pressure in pounds per square inch, d is the diameter of the pipe in inches, and L is the length of it in feet.

How can the iron losses in the armature core of a direct-current motor be ascertained by a simple and practical method? (2) Can the eddy current losses be separated from the hysteresis loss. H. M.

Drive the armature in an unexcited field by means of another motor and ascertain the amount of power absorbed by friction and wind resistance; this is ascertained by subtracting the power taken by the driving motor, when running free, from the power taken when coupled to the tested machine, taking note of the increased loss in the winding of the driving motor. Then excite the fields of the tested machine to the normal extent and drive it as before, noting the increase in power required by the driving motor. The difference between the power required with the fields excited and that required with them unexcited will be the power absorbed by hysteresis and eddy currents. (2) It is not possible to separate these losses by any simple practical method.

AN UP-TO-DATE NEWSPAPER PLANT

A small, but nevertheless interesting isolated plant, is that of the Hastings' Sons Publishing Company, of Lynn, Mass., publishers and owners of the *Lynn Item*, a local daily newspaper. The plant is located in the basement of the building, and consists of two 50-h.p. return tubular boilers and a simple engine direct connected to a 35-kw. generator, as shown by Fig 1. The equipment includes three motors of one, two and three horse-power capacity, respectively, in the stereotype department, two motors of 3 and 3½ horse-power in the linotype room, a ½-h.p. motor in the machine shop, a 30-h.p. and a 20-h.p. motor for two printing presses and a 7½-h.p. motor for running a passenger and a freight elevator. Besides this load the building is wired for 520 incandescent lights.

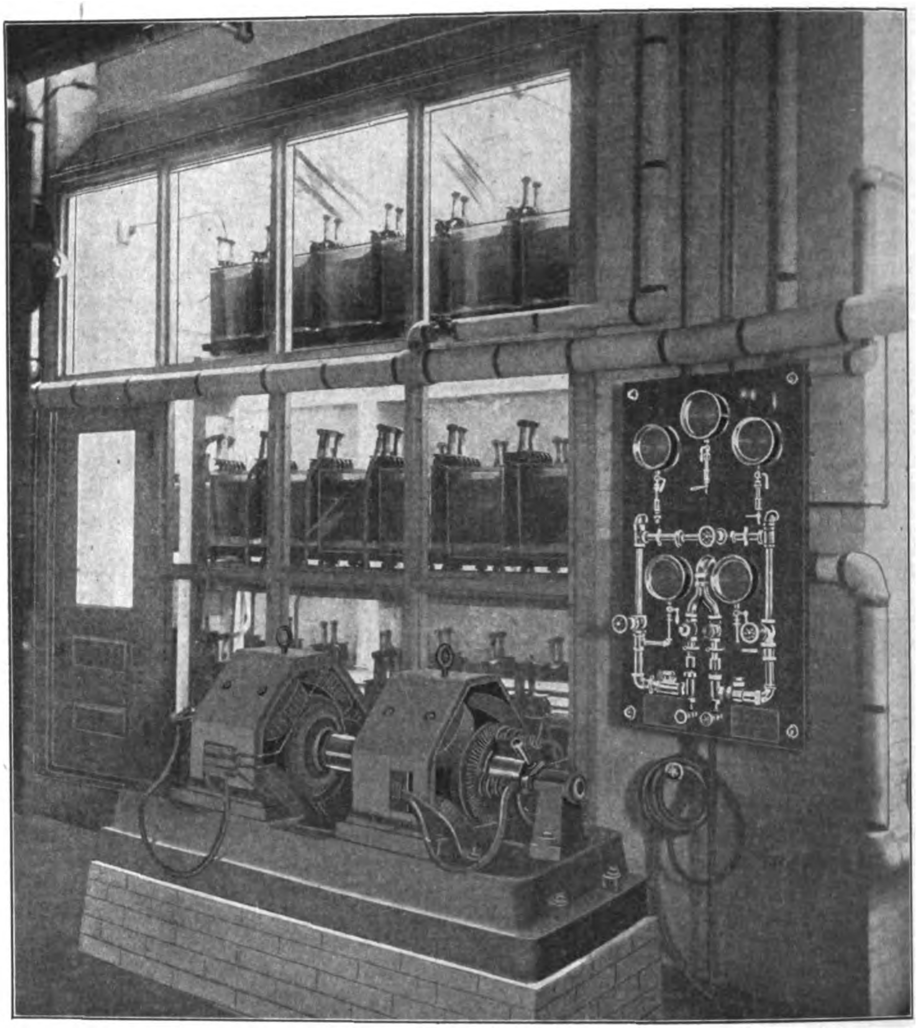


FIG. 2.—SHOWING ARRANGEMENT OF CELLS.

The lighting and steady motor loads during the earlier part of the day are not very heavy, averaging about 75 amperes. When the presses are in operation between 3 and 5 p. m. the average load is over 200 amperes, running up to 425 amperes frequently, and occasionally up to 600 amperes, when the presses and elevators happen to be taking power at the same time. Under these conditions it was found impossible to keep the lights from flickering, owing to the change of speed in the engine; hence a battery of 58 cells of Chloride accumulators was installed, and the power bus-bars separated from the lighting bus-bars; the two being connected through a constant-current booster. All of the unsteady power is taken from the bus-bars to which the battery is connected, and the constant-current booster transmits the average power required from the lighting bus-bars to these bus-bars; all of the steady current demand being supplied from the bus-bars that are fed directly from the generator. Under the heaviest and most sudden loads, the voltage variation on the lights, it is said, does not exceed 3 per cent, and ordinarily it is under 2 per cent.

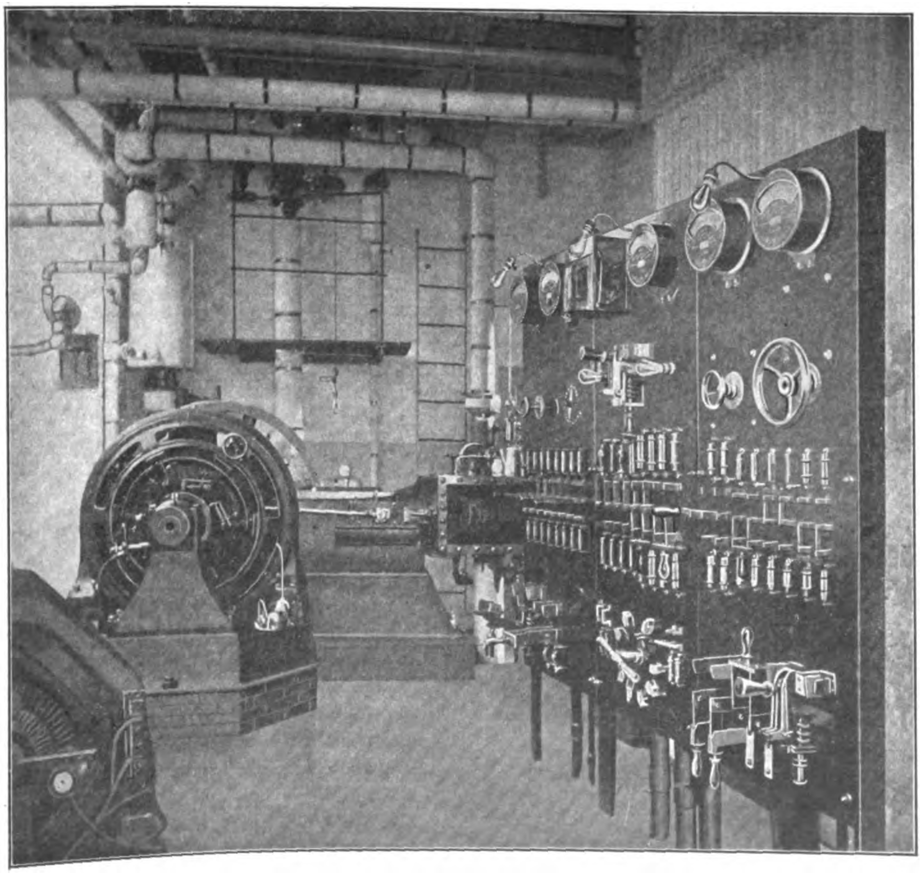


FIG. I.—VIEW OF SWITCHBOARD AND ENGINE.

The engine starts at 8:30 in the morning and operates until noon time, carrying whatever load is needed, and at the same time charging the battery. During the dinner hour, from 12 to 1:30, the battery carries the entire load of the building, and no attendance is required. At 1:30 the engine is started again and operates until 6 p. m., when it is shut down, the battery carrying the entire load of the building, amounting to about 30 amperes, up to 1 o'clock at night, after which time the load is light, consisting only of hall lights, and such lights as the watchman uses on his rounds. During the morning run the battery is recharged. In the summer months the engine is only run about six hours per day.

The switchboard consists of three panels with ammeters, voltmeter, recording wattmeter and all necessary instruments and switches for controlling, handling, indicating and recording the output. All circuits are arranged so that they may be connected either to the lighting or to the power bus-bars, and an arrangement is provided so that connection can be made with the city mains if desirable, through a special set of bus-bars, but this has never been done, as no necessity has ever arisen for outside help, the storage battery providing all necessary reserve against temporary accident.

The booster is a motor-driven machine of about 8 kilowatts capacity. The battery has a capacity of 200 amperes, which is capable of being increased 20 per cent by the addition of plates. It is installed in an extremely small floor space, owing to the exigencies of the plant, being placed under the sidewalk in a room 6 ft. x 20 ft. x 17 ft. high, lighted by glazed pavement in the sidewalk. The battery is arranged, as shown by Fig. 2, in two rows, three tiers high, and the light being from above gives good results for inspection purposes. The room is ventilated by a 12-in. x 12-in. shaft, running to the top of the building. Between the battery room and the engine room is a tight partition built of glass, providing plenty of light for the engine room and yet keeping out the fumes from the battery. The cement floor is drained by a connection with the sewer, in case water or acid should be spilled.

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THE CARE OF ENCLOSED ARC LAMPS.

The General Electric Company has issued some extremely practical advice concerning the subject of globe breakage, lamp adjustment, and the trimming of enclosed-arc lamps, which should be in the hands of every person who has to do with this type of lamp. We therefore reprint below the advice referred to, and commend it to the careful attention of every reader interested in enclosed arcs.

In the more modern systems of arc lighting, where the enclosed-arc type of lamp is used exclusively, the subject of the renewal of envelopes or inner globes is an important item of central station maintenance. Upon the condition of the inner globe and the joints at the holder and cap depend, to a large extent, the uniformity and length of the carbon life, which are two of the most important advantages claimed for the enclosed-arc system. In order to secure these advantages, however, it is evident that there must not be too free an entrance of air to the arc-enclosing globe, and that renewals of these globes must be made regularly, so as to avoid the continued use of defective globes.

A large percentage of unnecessary globe breakage can be traced to careless handling. No station manager or superintendent would countenance any evident carelessness of employees resulting in the cracking or breaking of a large number of globes. At the same time, however, a great amount of carelessness does exist, as will be shown by the number of globes having nicks at the top or bottom. These nicks, which are very easily overlooked, admit air and thus shorten the life of the carbon; they also form an excellent start for a crack when the globe is subjected to heat variation. No globe should be used which does not have perfectly-ground edges.

In transportation and the operations of cleaning and placing the globe in its holder and underneath its cap, as great an amount of ordinary care should be exercised as in the handling of other equally fragile glassware. Each lamp trimmer should make sure that no lamp on his circuit has a cracked or nicked inner globe.

Improper Lamp Adjustment.—The reason for excessive inner globe destruction by improper lamp adjustment can be readily seen by an examination of the globes, where effects of large power consumption at the arc and excessive heat will be evident. The globes will be found to be sagged on one or all sides due to softening of the glass, or the glass may be blackened at the top. A globe that has been subjected to this intense heat will not maintain a true surface contact and should not again be used.

No attempt should be made to use a lamp on a circuit for which it is not intended. Care should be taken to see that it is properly adjusted for the circuit on which it is to run, and neither the lamp nor its adjustments should be condemned unless, without question, the circuit conditions are what they are nominally supposed to be. This applies to the current strength on series circuits, the potential at the lamp terminals on multiple circuits, and the frequency on alternating-current circuits.

Careless Trimming.—Results somewhat similar to those caused by too high arc voltage may be obtained by the insertion of incorrect lengths of lower carbons, a "too long" carbon causing cracking or melting of the globe near the top, and probably burning the cap and forming a dark reddish deposit on the globe surface; a "too short" carbon causing the melting of the globe at the bottom, and partial or total destruction of the lower carbon holder. The use of lengths of lower carbon as advised by the manufacturer of the lamp should be adhered to.

Cleaning Inner Globes.—If an enclosing globe be merely wiped or brushed out at occasional trimmings it soon becomes discolored, due to the deposit being burned into the glass, and an appreciable percentage of light is cut off. The globe must then be either destroyed or cleaned with acid. Repeated use of acid shortens the life of the globe.

A Good Plan.—The very successful method of cleaning inner globes and trimming the lower holders at the station, as facilitated by the removable type of inner-globe holder, is strongly recommended. Having the globes brought into the station at each trimming will give the superintendent an opportunity to secure information regarding the system which otherwise would be very difficult for him to obtain. Here he has the globe and pair of carbons showing the condition of the lamp from which they have been taken. By examining the conditions of the carbons and comparing the length of them a very good idea is obtained both of the individual arc adjustment, and the uniformity of arc adjustment of all lamps of the system. Flat and mushroomed ends, together with exceptionally long residue carbons, indicate low arc voltage and a short arc; pointed carbons and short residue indicate a flaming arc and immediately suggest an abnormal arc voltage, or possibly undue entrance of air to the enclosing globe. An examination of the globe may disclose a crack, a nick at the top or bottom, a globe tilting or loose in the holder, or no asbestos washer.

Individual cases of short arc and long life might occur from an exceptionally hard pair of carbons or from the core having dropped out of the upper carbon. Again, a pair of very soft carbons might be responsible for long arc and short life, but generally speaking a comparison of results during a certain period gives an opportunity for an efficient organization which is sure to produce commercially satisfactory and even gratifying results.

AUTOMATIC WATER PURIFIER.

The sources and purity of water demand careful attention from the engineer proposing to use it for manufacturing purposes or for the generation of steam, since the presence of any foreign matter is always productive of some and sometimes serious difficulties and dangers. It is a well-understood fact that for most manufacturing purposes a fairly pure, or soft, water is desirable; and it is also known that rarely does such exist in nature. Rain, the purest form of natural water, contains certain gases which it collects from the atmosphere in its fall, and as soon as it touches the earth it begins to dissolve small portions of the various solid materials with which it comes in contact, and thus becomes charged with salts and other substances to an extent varying, of course, with the nature of the soil and rock which it has touched.

Various chemical reagents are relied on to throw these salts out of solution and the precipitate is collected by a process of filtration or merely allowed to settle. The addition of sodium carbonate (washing soda) removes the hardness due to the presence of calcium and magnesium sulphates, for both of these salts are decomposed by the sodium carbonate, which separates the calcium and magnesium as insoluble carbonates, while sodium sulphate remains in solution. By adding to the water a solution of quicklime, the dissolved bicarbonates of calcium and magnesium are robbed of a portion of their carbonic acid and are reduced to simple carbonates, which appear in the form of a fine insoluble powder.

These chemical reactions are found in most of the water purifiers on the market, and constitute the working principle of the Dervaux-Reisert purifier, the sale and manufacture of which are controlled in the United States by the Automatic Purifier Company, of New York City. The apparatus is automatic in its action, and it is intended to act as an eliminator for calcium sulphate and calcium and magnesium carbonates. It not only acts to precipitate the dissolved impurities, but also to collect those that are in suspension. The water enters at *H* and flows into the distributing tank *R*, which is provided with three valves placed at the same height; the first one *P*, controls the inflow of untreated water; the second, *V*, leads to the lime saturator *S*, and a third, *X*, leads to the soda chamber, *C*. A part of the distributing tank is partitioned off to serve as a lime-slaking chamber *J*. Here a quantity of lime, depending on the requirements of the case, is slaked daily and the paste conveyed to the bottom of the lime saturator. A constant flow of water from the tank *R* is conducted to the saturator through the pipe S_1 and, meeting the lime at the bottom of the saturator, passes up through it. The conical shape of the saturator causes the velocity of the rising water to be slower and slower as the water nears the top, so that the milk of lime at first formed has plenty of time to subside, leaving the lime water perfectly clear. The water then passes into the reaction chamber *D* through the pipe S_3, where it mixes with soda solution led from the soda chamber through the pipe C_3, and untreated water entering through the pipe *E*.

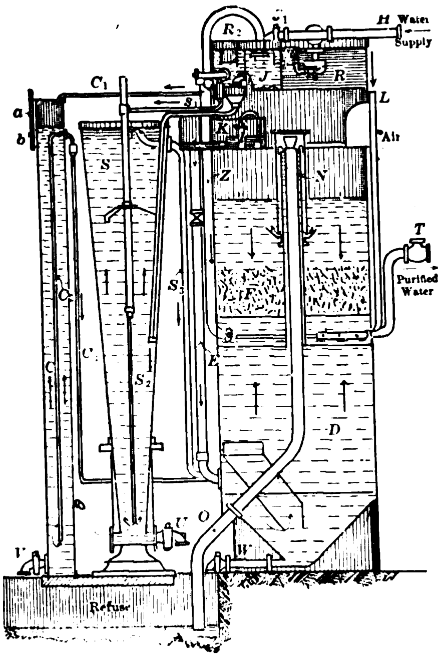

FIG. I.—CROSS-SECTION OF PURIFIER.

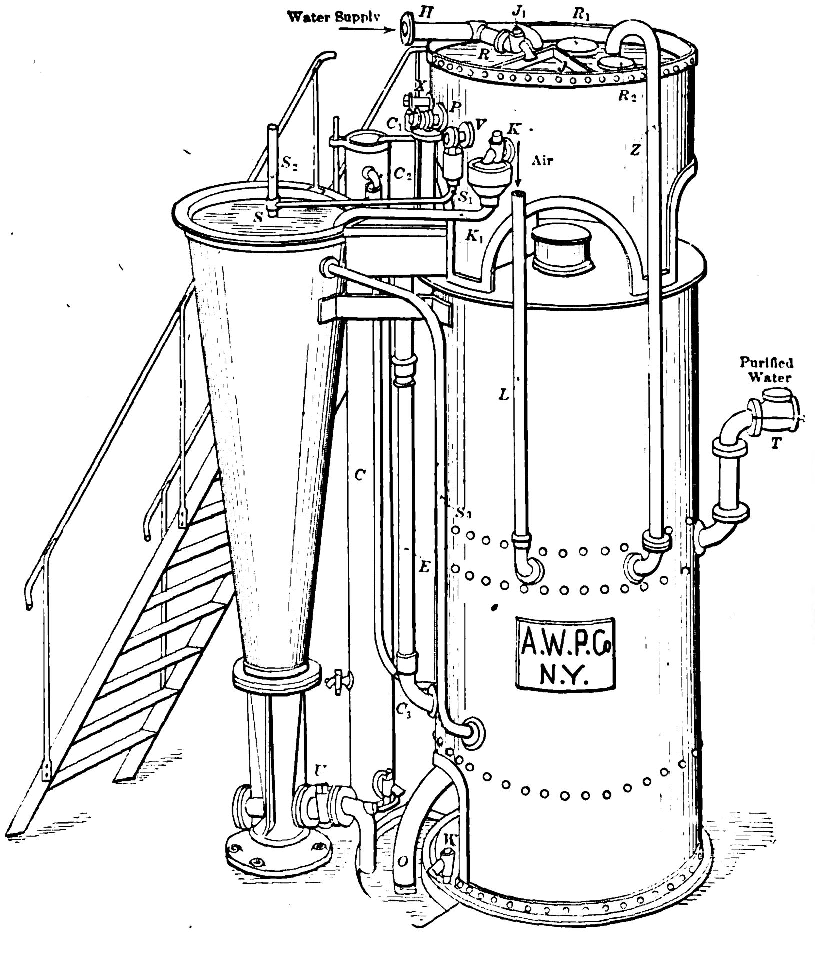

FIG. 2.—AUTOMATIC WATER PURIFIER.

Chemical action now takes place, and the carbonates and the sulphates contained in the water are precipitated, the precipitate being removed from time to time through the cock *W*. Through the pipe *N*, the water thus treated rises over the filter *F* and escapes in its purified state through the relief valve *T*. Should the filter become choked with sediment, an automatic arrangement is immediately set in operation and cleanses the filtering material with air and water. The sediment is carried out through the pipe *O* into the sewer, the water being supplied by the pipe *Z*. The cleansing operation stops automatically when the congestion is relieved and the filtering operation begins anew.

The attendance of the apparatus is confined to charging it once a day with lime and soda, and to opening the sediment cocks *U*, *W*. and *Y* for a few moments, in order to remove the sediment and to test the water by means of a testing apparatus accompanying the purifier.

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SCHEEFFER WATTMETER FOR ALTERNATING AND DIRECT CURRENTS.

The accompanying illustrations show some of the salient features of the improved Scheeffer wattmeter for alternating and direct currents, manufactured by the Diamond Meter Company of Peoria, Ill. Although there exist objections to meters of the type which employ a commutator, still where reasonable care is exercised in their design and manufacture excellent results are obtained, and such an instrument possesses the advantage of being applicable to alternating as well as to direct current. The new Scheeffer meter is of this type. Improvements are embodied in this meter, however, it is stated, which minimize the faults inherent in motor-meters with commutators, and the design differs somewhat from others of this type. One improve-

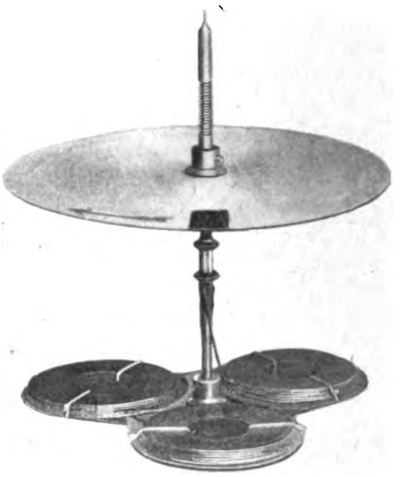

FIG. I.—ARMATURE.

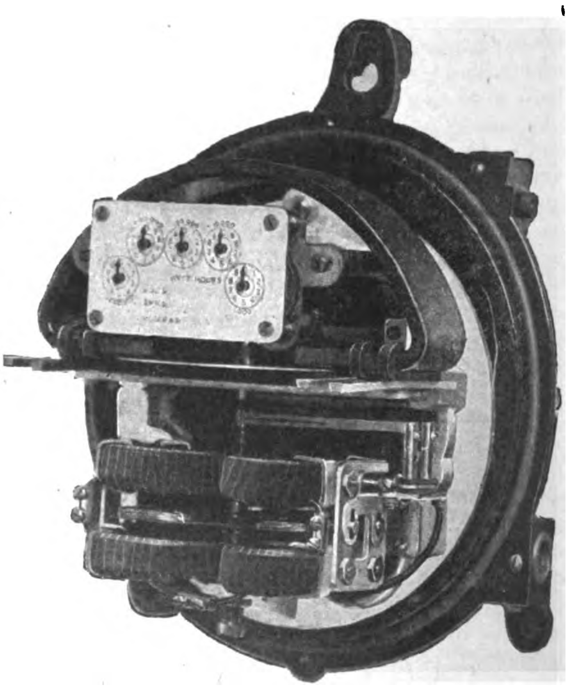

FIG. 2.—SCHEEFFER WATTMETER.

ment consists of a cast aluminum case instead of one of sheet metal, and this is held tightly over a rubber gasket against the back by screws, resulting in practically an air-tight joint with the consequent elimination of dust and dirt. The armature consists of a mica disc, on which are mounted three machine-wound coils of fine wire, as shown by Fig. 1. The commutator is one-eighth of an inch in diameter and has only three segments. The brushes press very lightly and the friction consequently is very slight. The form of damping magnet used is shown by Fig. 4. It is slipped on guide pieces and can be readily removed and replaced without disturbing the meter; nor is it necessary to disturb the magnet when calibrating the meter. A brass handle is provided on the left side of the meter and serves to move a piece of iron, whereby the speed of the meter at full load is readily adjusted. The armature can be taken out at any time, if necessary, by simply taking off the recording movement and the damping magnet. The brushes are two straight and elastic strips of phosphor-bronze, split for greater flexibility and located in plain sight for inspection; they can be slipped aside quickly for cleaning or replacing. The regulating resistance consists of a spiral of wire wound non-inductively and placed on a plate screwed on the back of the meter; one of these resistances is shown by Fig. 3. They are made up in discs for 100-volt units; that is: one is used in a meter running on a 100-volt circuit, two in a 200-volt meter, and so on. If the resistance is to be inspected, it is easily removed by unscrewing the back plate. In the disc form of armature, with three coils, the manufacturer claims an efficiency greater than that obtainable from the regular drum armature. The power in the shunt at 100 volts e.m.f. is said to be 2½ watts, and it is claimed that the drop through the series coil is very low. The meter requires the use of no constant and is direct-reading. It is provided with the Scheeffer improved ball-bearing and is of the same size as the well-known Scheeffer induction meter and somewhat lighter.

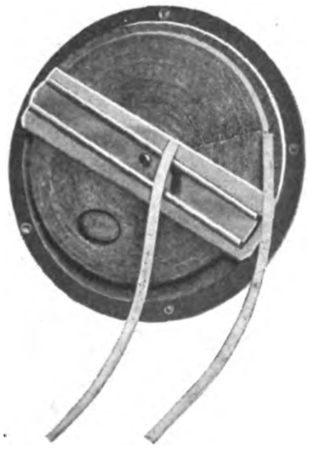

FIG. 3.—REGULATING RESISTANCE COIL.

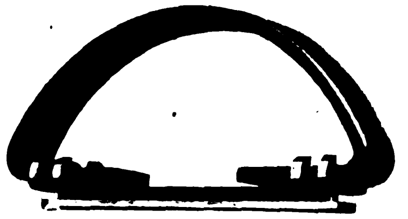

FIG. 4.—DAMPING MAGNET.

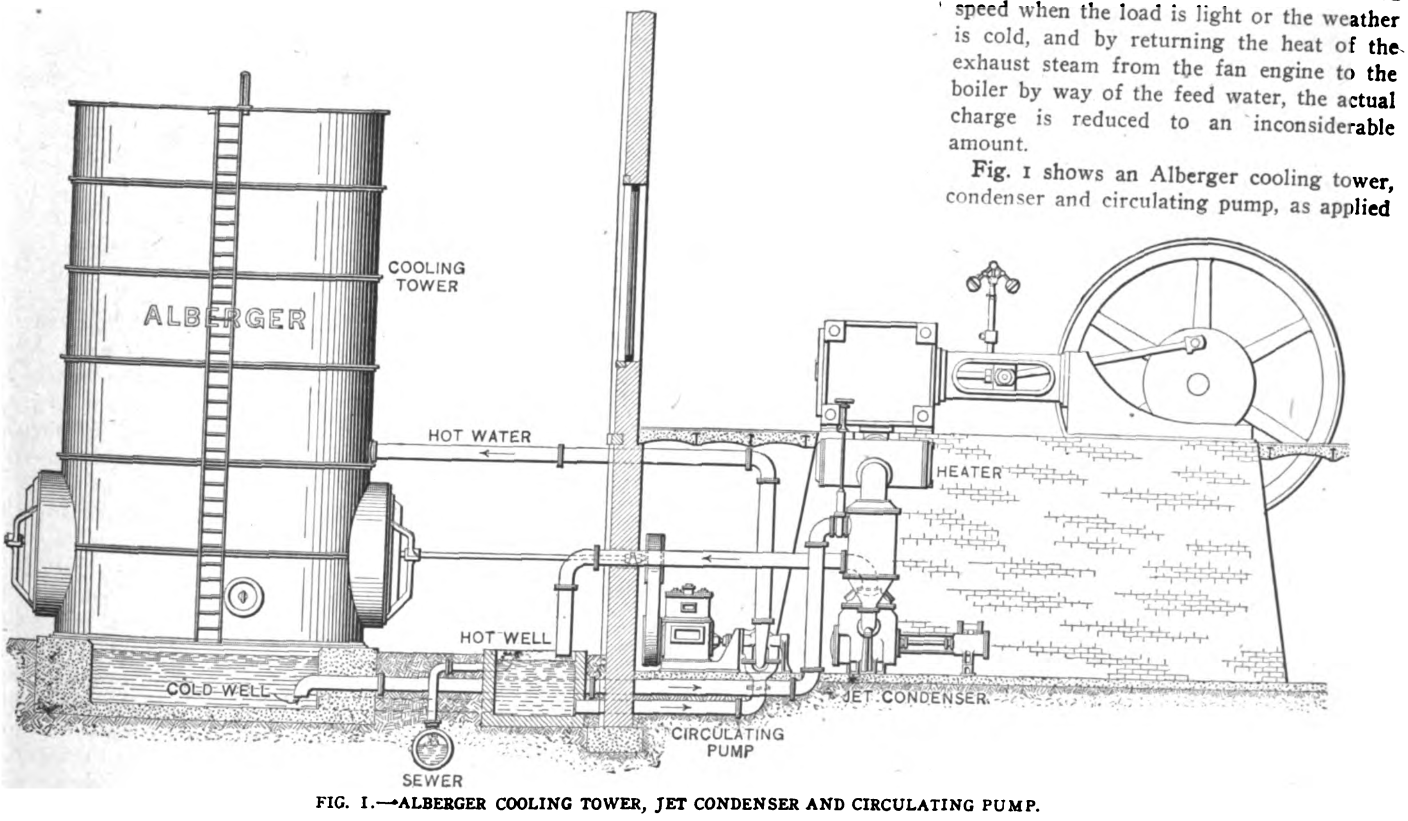

FIG. 1.—ALBERGER COOLING TOWER, JET CONDENSER AND CIRCULATING PUMP.

THE ALBERGER COOLING TOWER SYSTEM.

That the experimental stage of cooling tower practice has been passed is evidenced by the fact that numerous steam plants have been located where there is no natural water supply for condensing purposes, and have been equipped with condensing engines and cooling towers. This selection of site has been influenced by better coaling facilities, more favorable distribution of electric power, lower cost of land away from water fronts, and the knowledge that results practically equal to those obtainable with a natural water supply can be had with properly applied cooling towers. Another evidence of the practical character of the cooling tower is the increasing number of manufacturers of this class of apparatus.

One of the most recent forms of cooling tower is that of the Alberger Condenser Company, New York. The Alberger cooling tower is cylindrical in form, and is constructed of sheet steel, carefully riveted and braced. There are two types, one in which the air is circulated by means of one or more fans, and the other by means of a stack placed above the cooling tower proper, which produces a draft when the air becomes heated by the hot water from the condenser. The former type is especially suited for ammonia condenser work and for steam condensers where the space available is limited, or where the tower can be placed to advantage upon the roof of the engine or boiler house. While, of course, the power required to operate the fan is a constant charge, still by running the fan at a reduced speed when the load is light or the weather is cold, and by returning the heat of the exhaust steam from the fan engine to the boiler by way of the feed water, the actual charge is reduced to an inconsiderable amount.

Fig. 1 shows an Alberger cooling tower, condenser and circulating pump, as applied to an ordinary situation where the cooling tower can be placed upon the ground adjoining the engine room. The condensing apparatus shown is of the jet type, and takes its injection from the cold well and discharges into the hot well on the same level. Its functions are precisely the same as though a natural water supply were used for condensing purposes, but its operation is more thoroughly assured on account of the invariable suction lift and constant supply of cold water.

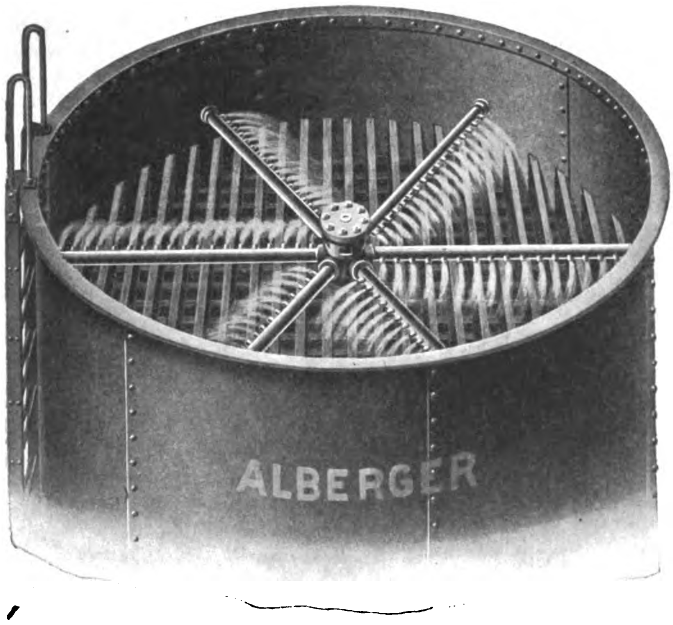

FIG. 2.—VIEW IN TOP OF TOWER, SHOWING DISTRIBUTOR.

The filling of the Alberger cooling tower consists of boards of swamp cypress, geometrically arranged in lattice form, so as to positively determine a complete and ultimate distribution of the water and the air, there being no haphazard arrangement of the filling or changeable condition that may divert the air and the water in any one particular direction. The filling is cut from the heart of the true swamp cypress, which is, as is well known, most durable and practically imperishable under the conditions of saturation that exist. The controlling idea in the design of this tower is to circulate the least possible amount of air and, by repeated and determinate subdivisions of the current, to bring it into contact with a large surface of water, and thus utilize its cooling power to the greatest extent.

The fans of the tower are operated by a steam engine, which also drives by direct connection a centrifugal circulating pump that withdraws the hot water from the hot well and discharges it to the distributor of the cooling tower. The distributor is shown in perspective in Fig. 2. It will be seen that the water issues from the arms of the distributor through tubes so arranged as to cause the water to retain its jet form until it reaches the filling, upon which it adheres and spreads. As each tube has to supply water for all the filling over which it passes during a revolution, it is of necessity of comparatively large diameter, and does not become clogged with leaves or other similar material, as might happen with small holes or slits. The hub of the distributor, which carries the arms, is rotated upon a roller bearing by the reaction of the jets of water. An even and practically perfect distribution of water over the filling of the tower is claimed, and it is said to be impossible for any portion of the filling to receive more than its proportion of the water while other parts receive less and are, perhaps, dry.

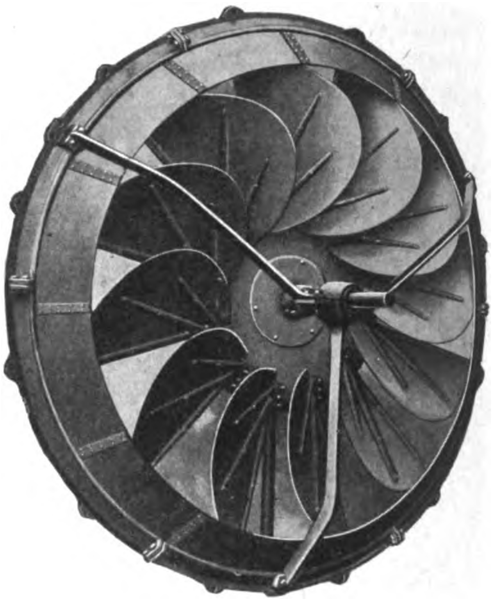

FIG. 3.—ARRANGEMENT OF FAN BLADES.

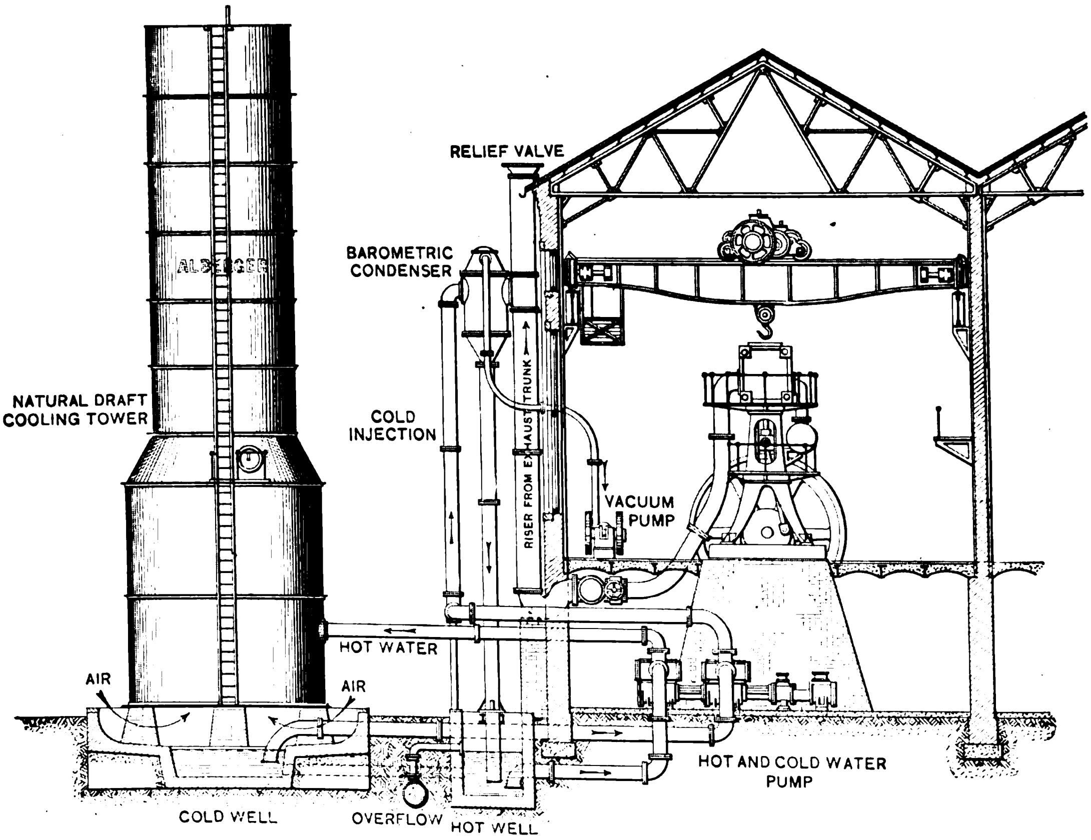

FIG. 4.—ALBERGER NATURAL DRAFT COOLING TOWER AND BAROMETRIC CONDENSER.

The fans used to circulate the air in the fan towers are the product of long experience and designed for continuous and long service. Fig. 3 illustrates the method of attachment of the blades to the steel hub, and also the shape of the blade. The bearings are of the ring-oiling type, fed from a reservoir, and require attention only at long intervals.

The Alberger natural-draft cooling tower represents the most advanced type, as no power is required to circulate the air. This tower is preferably about 80 ft. high, and consequently should be placed on the ground level. It is an excellent apparatus to use when it is desirable to deliver the vapor from the tower at a level above adjoining buildings, or where the tower must be at some distance from the engine room, and such a location renders inconvenient the transmission of power to the fan of a fan tower. The arrangement of filling employed is the same as that already described, except that it is placed at the extreme bottom of the tower, and the air is allowed to enter around the piers that support the structure of the tower. The distributor is the same as that used with the fan tower, and the stack is connected to the top of the tower by means of a conical section, as illustrated in Fig. 4. Two or more of these towers can be operated in a battery with the same results as when a single tower is employed.

The condensing apparatus shown is the Alberger barometric condenser, and is especially suited to large engines or to stations containing a number of engines, which may be exhausted into one condenser. The distinctive features of this type of condenser will be described in another article. It will be seen that the circulating pump comprises hot and cold water pumps, operated by the same steam cylinders. The cold water pump derives its supply of water from the cold well of the cooling tower and discharges into the condenser, being assisted by the vacuum in the latter. The water is removed from the hot well by the hot water pump and delivered to the distributor of the cooling tower. In this tower and in the fan tower, when used in connection with steam condensers, the water produced by the condensation of the exhaust steam is sufficient to compensate for the evaporation in the tower, and none need be supplied to the system. There is, on the contrary, a slight overflow, which carries with it the oil from the engine cylinders, and in this manner constantly cleans the system of oil that would otherwise accumulate in the hot well. There are no places in the cooling tower which form hiding places for the oil, and the constant overflow maintains a uniformly operative condition of the entire apparatus.

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HIGH-TENSION ELECTRO-MECHANICAL SWITCH.

The accompanying engravings illustrate one of the latest forms of high-tension switches built by the General Incandescent Arc Light Company, New York. The switch here shown was built for a 6600-volt, three-phase circuit, and is of 300 amperes capacity. The switch chamber is of brick, divided by soapstone partitions into three compartments, one for each phase, and has a removable soapstone front. In each compartment are two oil wells, consisting of seamless brass tubing, with insulating lining, mounted upon porcelain insulators and connected by a copper ∩ connector. A wooden rod, which, after heating to drive out the sap, has been boiled in paraffine for 24 hours, connects this ∩ mechanically to an iron rod at the top of the switch to which the connectors in the other two phases are similarly fastened. This iron rod has a motion of over 14 ins., and when raised lifts the connectors in the oil chambers so as to make two 12-in. breaks in each phase. The switch is actuated by two solenoids, shown in Fig. 1, which operate a crank and connecting-rod movement so arranged that very little work is required of the solenoid at the beginning and end of its motion. The cores of the solenoids are connected by a steel tape passing over a wheel, which is turned 180 degs. to the right or left, as the right or left solenoid is excited.

Guide rods are provided, which prevent binding against the soapstone cover and insure the accurate alignment of the contact parts. If it is desired to operate the compartment switch by hand, a pair of rods with screw eyes at the base are provided, into which can be hooked a handle for operating it manually. Air bumpers are supplied to take up the final shock of the solenoid cores, so that no jar is transmitted to the supporting structure.

Fig. 2 shows the connection by which the main switch is operated from the switchboard or by the time limit relay. The cut shows the switch open; to close it, close the operating switch, thus energizing the right-hand solenoid. The switch starts to move, and almost instantly the blade *A* moves from point *1* to point *2*, shutting the operating switch so that the motion of the main switch must continue until it is completely closed. At the moment of closing the blade *A* moves from point *2* to point *3*, leaving the switch ready to be opened. In opening, the blade *A* jumps first to point *4*, shunting the operating switch, and when the main switch is open, returns to *1*, completing the cycle, and leaving the connections, as shown in the figure.

The time-limit relay is operated by current transformers in the feeder circuits. Should the current in the feeder exceed the amount for which the device is set, one of the small plungers shown is raised, and releases a disc, which revolves until it closes the circuit of a tripping solenoid which opens the operating switch. This opens the main switch in the manner already described. The relay may be set so as to take any desired amount of time after the contact disc starts before it finally opens the operating switch. The figure also shows the connections by which the pilot lamps indicate to the operator the position of the main switch. The contacts for this are independent of the position of the operating switch. Switches of this form are in operation in the new Waterside station of the New York Edison Company.

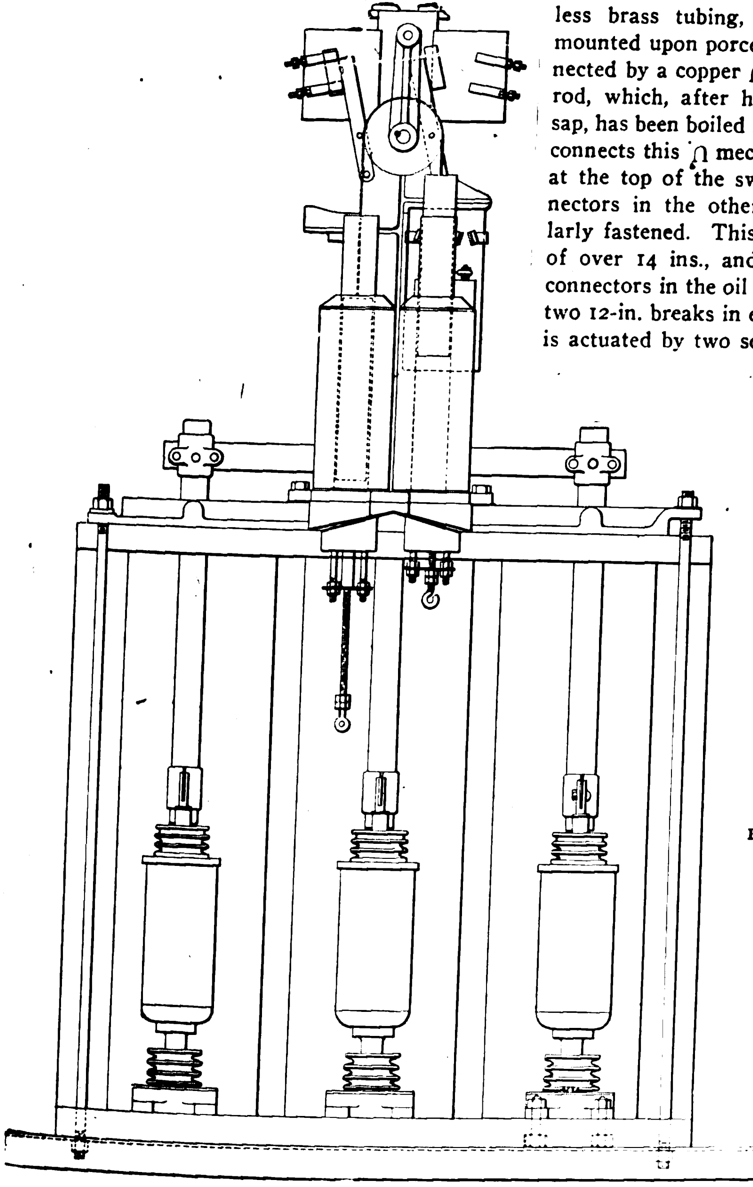

FIG. 1.—GENERAL INCANDESCENT OIL SWITCH.

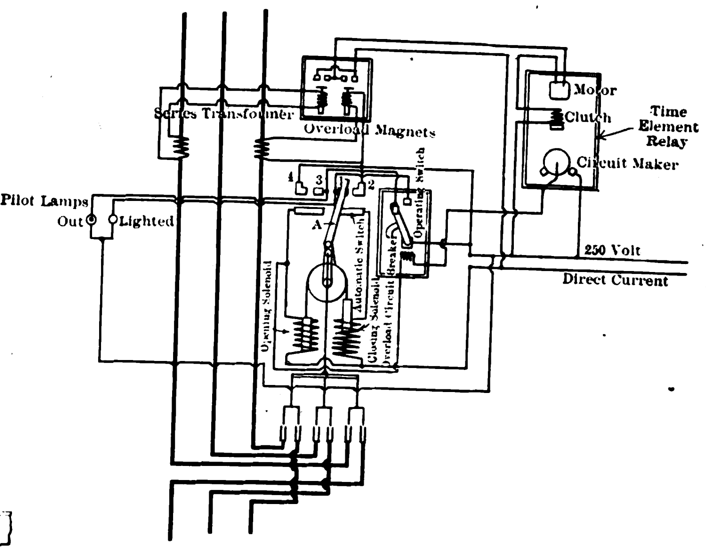

FIG. 2.—DIAGRAM OF CONNECTIONS.

New Apparatus and Appliances

COLE OUTLET BUSHING.

Fig. 1, herewith, shows the Cole outlet bushing made by S. B. Condit, Jr., & Co., of Boston, Mass. The bushing is said to ground the conduit system to the outlet boxes in a thorough manner. It is made of malleable iron, and has the advantage that the conduit need not necessarily be cut to the exact length where it enters a box, as the bushing fulfills the same requirement as a coupling, thereby saving time in installing. The lock-nut shown has sharp projections, and where the nut is screwed up tight the lock washer is said to cut itself into the box, making a good electrical connection, and at the same time springing enough to lock itself firmly in place.

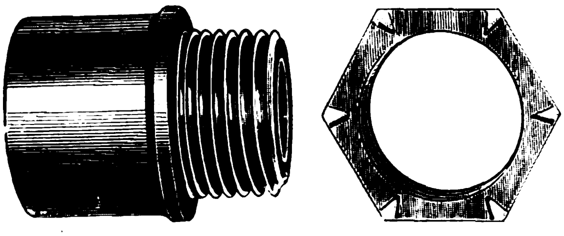

FIG. 1.—OUTLET BUSHING.

DU MONT PATENT CORNER BRACE.

The familiar type of brace shown by Fig. 2 has been somewhat improved recently by the Du Mont Tool Company, of Buffalo, N. Y. The improvement consists of a malleable iron socket in which the end of the sweep, or crank, turns, and to which the head is secured. This socket protects the head from injury and forms a rigid means of attachment for the angular frame, so that should the head become split from any cause, the effectiveness of the tool will not be seriously impaired. The universal joint is made of hardened steel, and the steel rod and other parts are heavily nickeled. The brace is made with an 8-in. or 10-in. sweep.

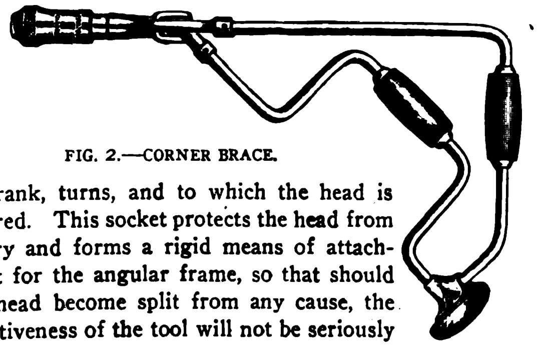

FIG. 2.—CORNER BRACE.

ENGINE-TYPE GENERATOR.

Fig. 3, herewith, shows an engine-type generator built by the New England Motor Company, of Lowell, Mass. The frame is made of soft, gray cast-iron, free from blowholes, and of such section as to give the best results when used in conjunction with the wrought-iron field cores and annealed laminated-steel pole-shoes. The field cores are cast-welded into the field ring, and the shape and proportioning of the elements of the field are said to be such as to reduce the distortion due to armature reaction to a minimum. The field coils are wound of cotton-covered wire on formers, and are then insulated by several layers of mica and fibrous material, taped, and painted with a water and oil-proof varnish. The series coils are made of copper strip. The armature is of the usual slotted-core iron-clad type, built up of soft annealed discs giving about fifty laminations to the inch. The discs are insulated by paper and keyed to a cast-iron spider, which also supports the shell of the commutator, being clamped in place by heavy end-plates. The armature coils are form-wound and hand-taped, and the armature slots are separately insulated with micanite cloth and pressboard before the coils are placed in them. Wooden wedges are used to hold the coils in the slots, and ventilating ducts are provided in the core of the armature. The commutator bars are held in position by heavy cast-iron collars, and are supported on the armature spider, and not upon the shaft, so that the latter may be pressed out and replaced should occasion require, without interfering with the commutator. The brush holders are of the tangential type, with adjustable spring tension. They are fastened to studs attached to a ring which revolves in a casting bolted to the frame. This is a feature of the generator, and gives a continuous bearing to the brush ring in contradistinction to the usual ring which is supported at wide intervals around its periphery. Carbon brushes are used, and are of such size, it is said, to carry a 50 per cent overload for two hours without undue heating.

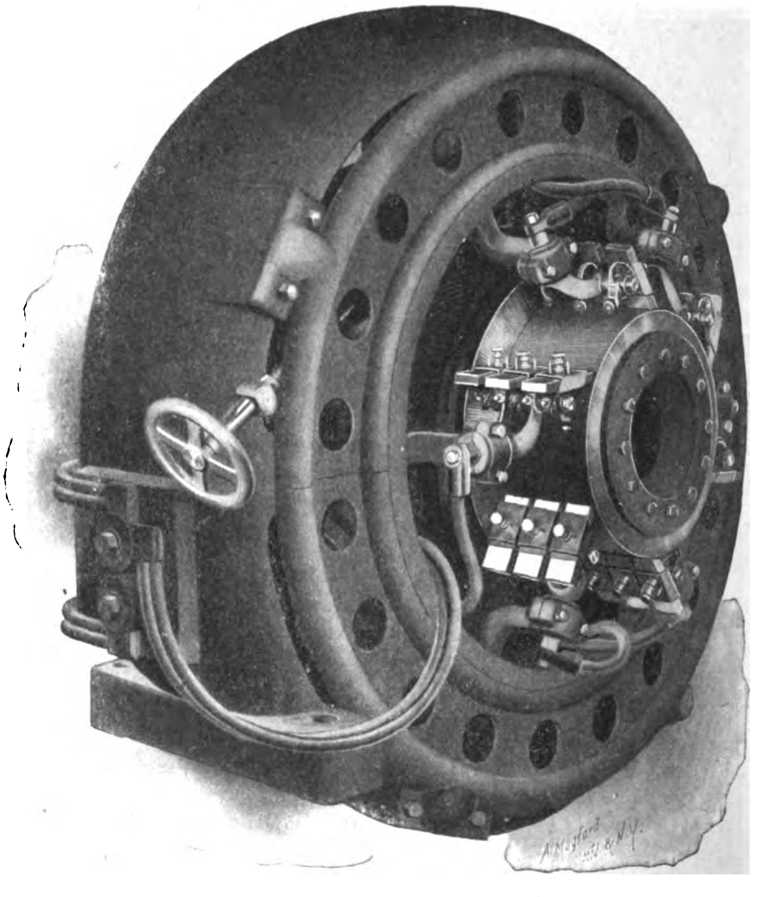

FIG. 3.—ENGINE TYPE GENERATOR.

SPINNING JENNY FOR TELEPHONE WORK.

Fig. 4, herewith, shows a spinning jenny brought out by J. S. Barron & Co. of New York City for use in binding telephone cables to the supporting wires. The device is made in two sizes, 18 ins. and 24 ins. long, with an inside diameter of two inches. The operation of the jenny is very simple. Being split longitudinally, it can be placed in position encircling the cable and supporting wire at any point on the line. The two sides are provided with dowel lockings and are copper lined to prevent any injury to the cable. The marline for binding purposes is wound around the jenny in one or more layers as the case may require, and the outer end is fastened at the place of starting. The cable to be bound is elevated by a snatch-block, hung on the supporting wire just ahead of the jenny, and the binding is done by the marline, spinning off as the jenny is pulled along the wire by means of a rope fastened to the iron arm. The rear end of the jenny is beveled so as to permit the marline to play off smoothly.

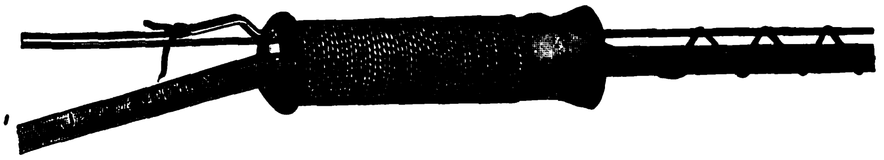

FIG. 4.—SPINNING JENNY.

A NEW SUSPENSION HOOK FOR TRANSFORMERS.

One of the most annoying incidents attendant on the substitution of new transformers for old ones is the difficulty sometimes experienced in detaching the old transformer case from the suspension hook on the pole or building. This is sometimes caused by the rusting of the hook to the case, and in many instances by the rusting of the nut and bolt usually employed to fasten the hook to the case, making it impossible to separate the two without the use of a cold chisel. In connection with its new line of Type A oil transformers, the Fort Wayne Electric Works has introduced the device shown by Fig. 5, herewith, which is said to overcome this difficulty and to be convenient of application. The illustration shows the ordinary transformer hook used in mounting the transformer box on cross-arms, etc., but instead of separate machine bolts, riveted studs on the hook shank engage with the pocket in the lugs and an eccentric cam-locking device. These permit the hooks to be readily attached to the transformer before it is elevated to its position, or the hooks can be set in place on the pole and the transformer raised by means of eyebolts in the case, until the pockets *AA* on the back of the case engage with the rivets or studs *BB* on the hanger irons. In either case, the eccentric cams *C* can be driven home with a hammer with just sufficient force to drive the studs well up into the pockets. By this means the transformer is rigidly attached to the hanger irons; but it is said to be very easy to, at any time, detach and remove it without disturbing the hooks, and without the use of tools.

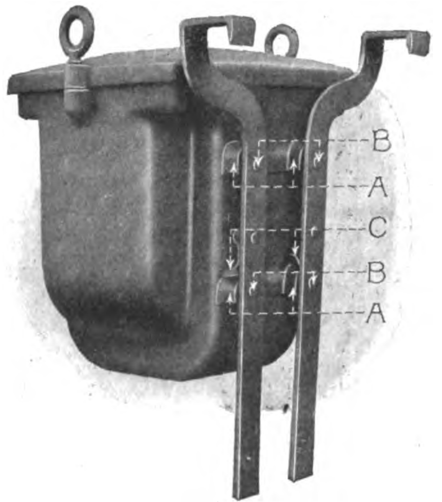

FIG. 5.—TRANSFORMER SUSPENSION HOOK.

DUPLEX OIL FILTER.

Among the numerous oil filters on the market is the "White Star," manufactured by the Pittsburgh Gage & Supply Company of Pittsburg, Pa., a duplex type of which is shown by Fig. 6. In this filter the oil is fed to the several cups from an elevated reservoir, and, after passing through the bearings is carried to the filter, where it is purified and pumped back into the storage tank. A third pipe carries any surplus back to the filter and prevents any overflow; the supply of oil is thus uniform. The filtering operation may be traced in the engraving. The contaminated oil enters the auxiliary tank on top of the main body, and after being drained through a removable screen passes through a screened funnel, suspended in the central compartment, into the warm water at the bottom. By the continued action of the heat supplied by the steam coils, the oil is thinned and the impurities separate more easily by the action of gravity. These impurities accumulate at the bottom of the chamber and are flushed out through a drain connection, while the oil is automatically carried off by an overflow pipe at the back of the filter. The constant admission of oil to the separating chamber eventually causes the oil to reach the level of the outlets near the top and to flow into the adjacent filtering cylinders. Specially prepared cloth is wrapped around these cylinders, and in passing through the body of the cloth, the oil is further freed from impurities.

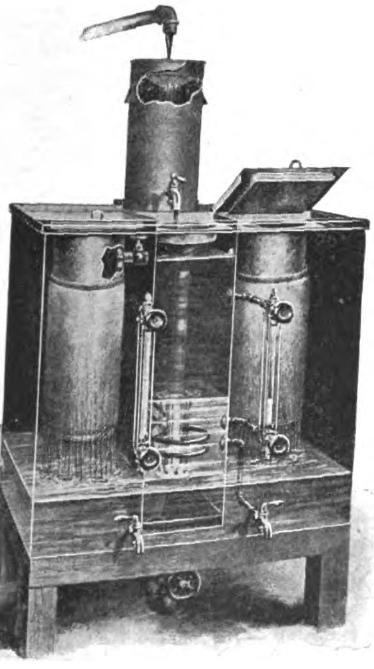

FIG. 6.—DUPLEX OIL FILTER.

SIDE-CUTTING PLIERS.

The side-cutting and splicing pliers shown by Fig. 7, herewith, is made by the Smith & Hemenway Company, New York, from special steel. It is provided with round edges for convenience in carrying and handling, and has polished head and jaws. Six sizes are manufactured, and these are supplied in half polish, full polish or nickel finish. The cutting edges are extra hard, and capable of cutting steel and hard iron wire.

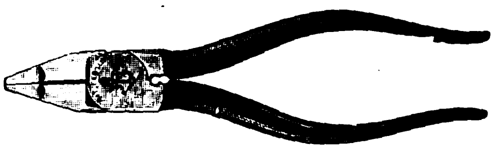

FIG. 7.—SIDE-CUTTING PLIERS.

MARINE GENERATING SET.

The marine generating set shown by Fig. 8, herewith, was designed to meet a demand for a small and compact set, extreme lightness being especially desired. For this reason aluminum has been used extensively in the construction of parts not requiring great strength. The dynamo is of the multipolar type; the ring and poles being of wrought iron, reduced in weight to as great an extent as the requirements of the machine would allow. The armature is of the laminated, drum-wound type, and is mounted upon the engine shaft. The brush-holders are of the radial type, such as are used on all Holtzer-Cabot machines. Self-oiling and self-aligning bearings are used. The illustration shows the dynamo direct-connected to a Herreshoff engine. This engine was said to be designed especially for this class of work, and is of the slide valve

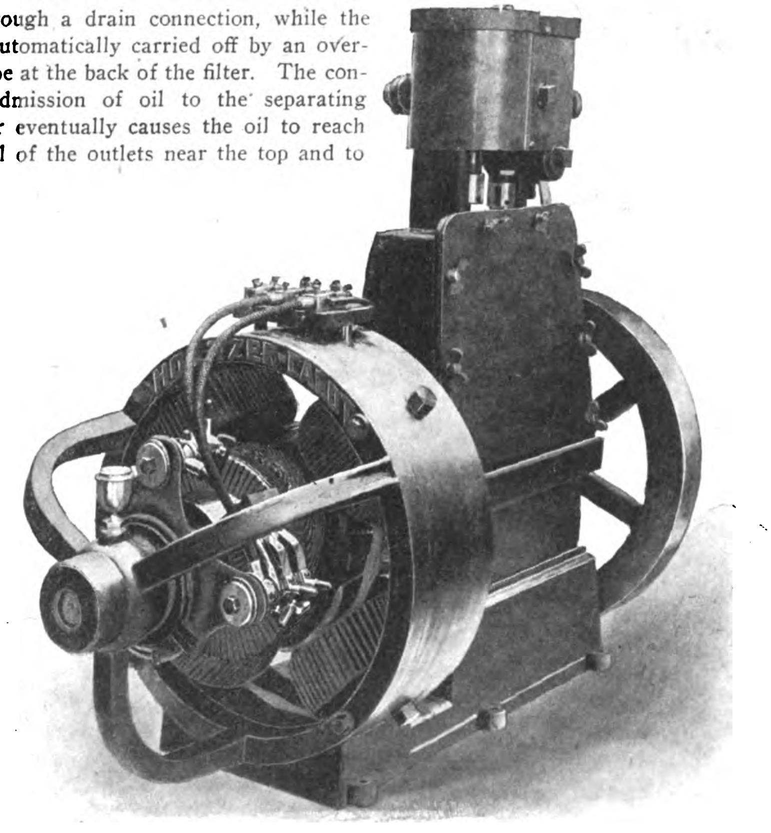

FIG. 8.—MARINE GENERATING SET.

pattern, with throttling governor. As will be observed, all of the working parts are completely enclosed, and run in oil. The set is said to weigh 298 lbs., and it is claimed will supply thirty 16-c.p. lamps, or give an output of 5 watts per lb. of weight when running at a speed of 850 r.p.m. The set is manufactured by the Holtzer-Cabot Electric Company, of Boston, Mass.

THE "NECO" INTERIOR TELEPHONE SET.

Fig. 9, herewith, illustrates a new telephone set that has just been brought out by the Novelty Electric Company, Philadelphia, and is known as the "Neco." One of the features of the outfit is the mounting of the transmitter; an iron box that encloses the parts forms the front plate of the transmitter, and as the diaphragm has a perfectly rigid seat, the operation of the transmitter is not impaired by vibrations of the mounting. The transmitter is of the granulated carbon type, made in conformity with the best practice. The receiver is of the watch-case type, provided with a powerful magnet, and is very sensitive. The outfit is designed for short-line service, although by adding an induction coil it is equally well adapted for lines of any practical length.

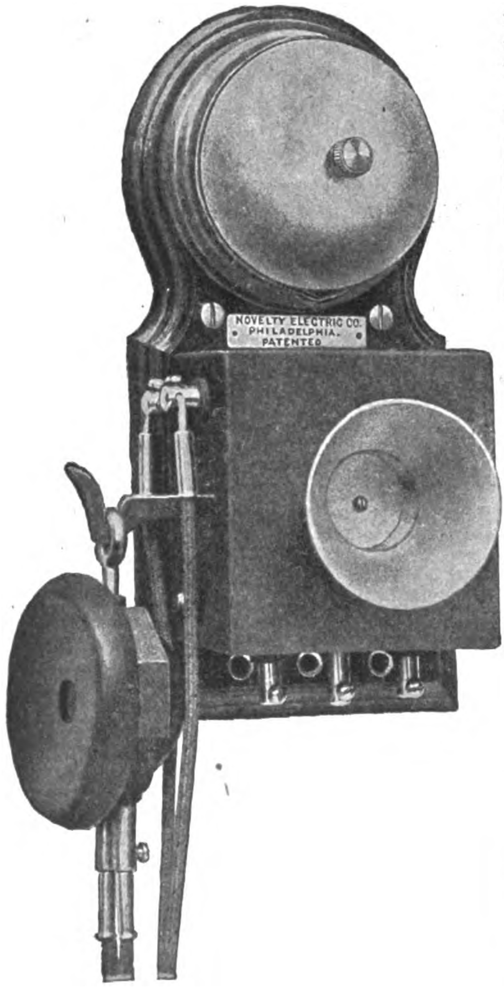

FIG. 9.—"NECO" TELEPHONE SET.

While compact and unpretentious in appearance, it is by no means a toy; all parts are of substantial construction, and the exterior is highly finished. The bright parts are heavily nickeled and the box is enameled. The illustration is just half size, as compared with the actual linear dimensions of the apparatus.

GLAZE-FILLED INSULATORS.

It is known that in the matter of glass and porcelain insulators for high-tension transmission lines, the latter have the advantage as regards mechanical strength; but the difficulty has been to produce high-voltage insulators of porcelain uniformly free from flaws. R. Thomas & Sons' Company, of East Liverpool, Ohio, claims to have accomplished the task of producing flawless insulators of porcelain which have also great mechanical strength. The insulator is "glaze-filled" and is patented by J. W. Boch, whose invention is based on the seemingly obvious fact that a thin piece of clay will mould and vitrify better than a thick piece. For this reason the insulator is made of two or more shells nested together. In Fig. 10 the figures *1*, *2* and *3* indicate the three shells which make up a triple petticoat insulator. The inner piece, *3*, is moulded with a suitably-threaded socket, as shown by *4*, for the usual pin, and the outer shell, *1*, is provided with the usual notched head for the conductor; and, like the intermediate part, *2*, is made bowl-shaped, so that the three are relatively thin shells nested into each other. The individual parts are first dried separately in an oven, or kiln, by a process known as "biscuit firing:" the separate parts are next coated with glaze by being dipped in the glazing material, and are then fitted into each other and placed upside down in the position shown at *5*. The parts thus put together and supplied with extra glaze at the joints, are put in the sagger with the petticoats uppermost and placed in the kiln. The glazing material melting, the shells are welded together by seams of glass-like glaze, which, it is claimed, are stronger than any of the other parts of the insulator.

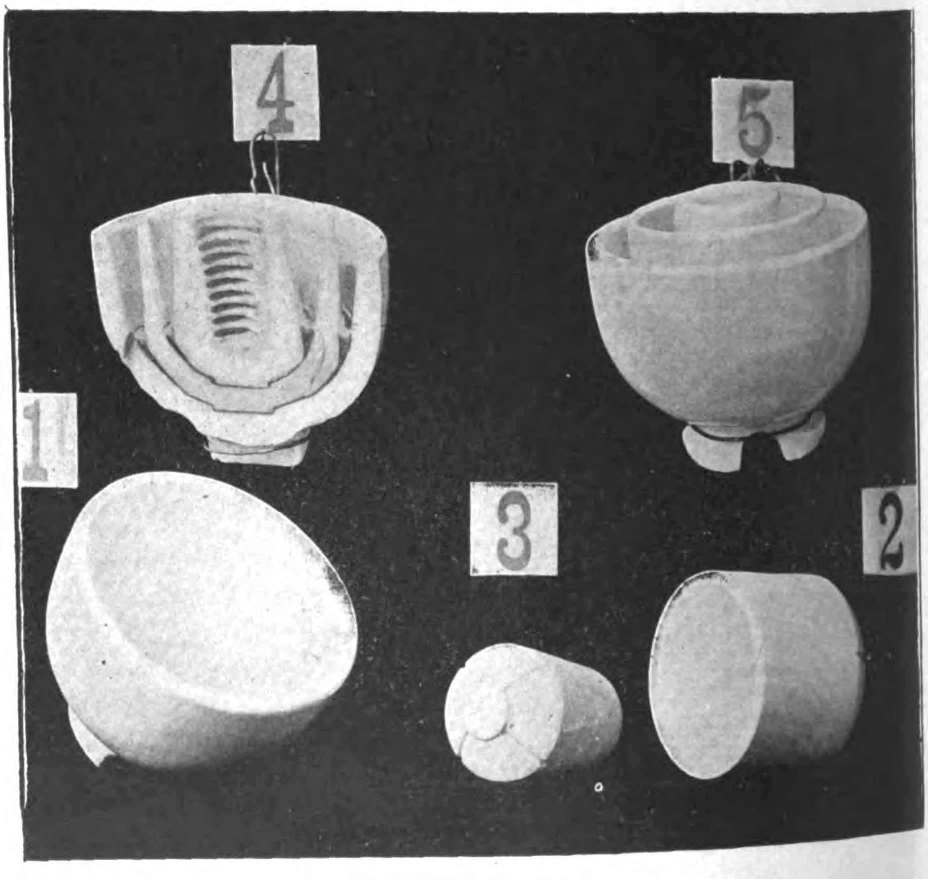

FIG. 10.—GLAZED-FILLED INSULATORS.

KNIFE SWITCH.

The Reading Gas & Electric Fixture Company of Reading, Pa., is placing on the market a line of knife switches, one of which is shown by Fig. 11, for which they claim the elimination of many troubles which have heretofore confronted the manufacturers of this class of apparatus. Two of the points upon which particular stress is placed, and for which superiority is claimed, are the method employed in fastening the blades and handle to the cross-bar.

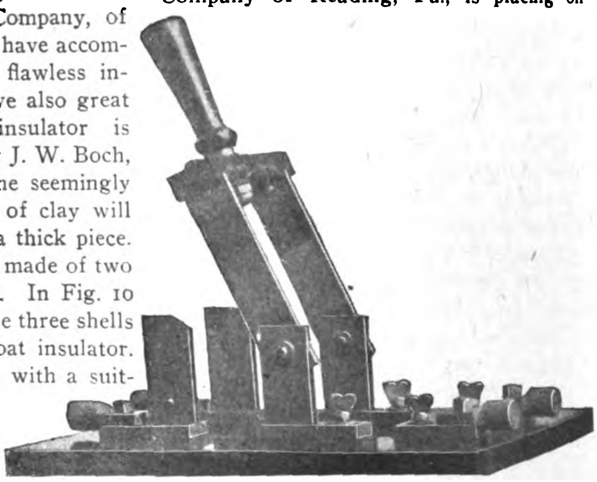

FIG. 11.—KNIFE SWITCH.

so as to make them mechanically secure; and the perfect contact which is said to be secured by grinding the blades in their respective jaws after the parts are all assembled.

BACHMAN SYSTEM OF WATER PURIFICATION.

As is well known, almost all water used for industrial purposes and generation of steam is charged with foreign matter in solution, such as lime, magnesia, sulphur, iron, etc., and also carries in suspension variable quantities of sand and vegetable matter. When such water is used in boilers without being first purified, the result is the formation of scale upon the tubes and inner surfaces. Various systems for softening and purifying the water prior to feeding have been devised, which operate by precipitating the sulphates of lime and magnesia with a solution of soda ash, and the carbonates with a lime solution. This is also the principle of the Bachman system, the agents for which are D. W. & R. P. Patterson, of Philadelphia, Pa. The various steps in the purifying operation can be easily traced by reference to Fig. 12. The water after leaving the heater enters the top of the precipitating tank, where it mingles with the lime water, which throws down the carbonates. It then passes through a partition, said to be so arranged as to keep the water circulating, into the lower chamber of the precipitating tank, where the sulphates are thrown down by the soda ash solution. Thence the water passes through a filter having crushed flint as the cleansing material, to the boiler. The filters are arranged so that when the filtering surface of one becomes clogged, the water is passed through the other and the clogged filter cleaned, forcing water up through it from the bottom and out through the wash-out pipe. In order to determine the condition of the water in the different stages of purification, three test cocks, *A*, *A-1*, *A-2*, are provided. A glass of water from *A* should assume a pink color upon the application of one drop of phenol solution to each tablespoonful of water. A similar test of water taken from *A-1* should show a slightly darker color, and if these colors are obtained from these two tests it is indicative of a proper working of the apparatus. As a final test, however, a glass of water is taken from *A-2* and a small portion of sodium hydrate or phosphate added; if scale-forming matter is present, the solution shows a flocculent precipitate, and if the quantity is very minute the water will remain clear or show only a slight cloudiness.

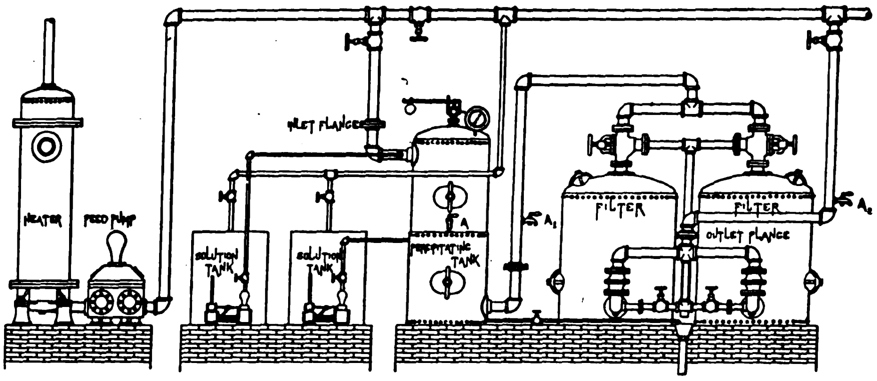

FIG. 12.—BACHMAN SYSTEM OF WATER PURIFICATION.

WEINLAND BOILER TUBE CLEANER.

Fig. 13 herewith illustrates the Weinland improved turbine boiler tube cleaner made by the Lagonda Manufacturing Company of Springfield, Ohio. The cleaner is connected to a supply of water having a pressure of at least 70 lbs., an improved coupling being provided which, it is claimed, will hold the hose securely under any pressure suitable for the apparatus. The cleaner is then inserted in the tube and the water turned on, its force being applied directly to buckets, which are arranged on the plan of a turbine water-wheel. The cutters are placed on arms pivoted as shown, and the centrifugal force keeps them in contact with the scale. The water which escapes from the buckets flows out through the tube, carrying the loosened scale with it. The spider to which the arms are attached is almost solid, and steel ball bearings are provided at both ends at the revolving part, so that strength coupled with flexibility and ease in running are obtained. The apparatus is made of brass and steel, all wearing parts being interchangeable.

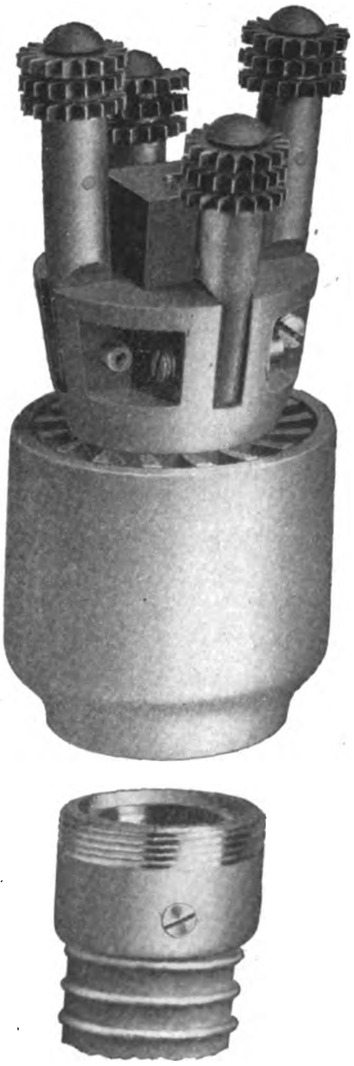

FIG. 13.—TUBE CLEANER.

A NEW TELEPHONE.

Owing to the rapid increase of private line telephones, there is a growing demand for a first-class inexpensive telephone—that is, an instrument which "talks" perfectly, rings perfectly, which will not get out of order, and also finished in the manner that becomes telephone apparatus. The Atwater Keat Manufacturing Works, of Philadelphia, has devoted a large amount of time and considerable expense in developing an instrument of this type, which is now being placed on the market under the name of the "Monoplex" telephone. A number of advantages are claimed for this type for use on short lines. The hook has a long lever, and consequently there is a maximum motion at the contacts with a given motion of the hook. The receiver is of the watch-case type, and, aside from the rubber ear-cap, is in one piece. There is thus no chance for a change in adjustment or of parts becoming loose. All connections are soldered, and the binding posts are so marked that there is no chance of mistake in connecting. Two wires are all that are needed between any two instruments, and complete directions for setting up are sent with each telephone. The Monoplex telephone, it is claimed, will talk over a distance of three miles, and is thus admirably adapted for use in office, factories, hotels, apartments and private houses.

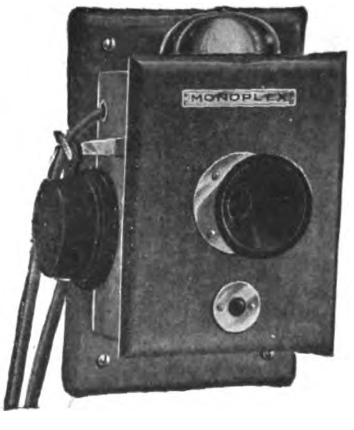

FIG. 14.—MONOPLEX TELEPHONE.

OBITUARY.

JOHN H. CASSIDY, the well-known manufacturer of electric and gas fixtures, died at his home in West Orange, N. J., May 3. Mr. Cassidy was 82 years old, and was one of the pioneers in the manufacture of electric and gas fixtures. He leaves a widow, a daughter, Mrs. J. B. McCoy, of South Orange, and a son.

DAVID R. WALKER, who was for more than 40 years connected with the Electrical Bureau of Philadelphia, and was for 18 years chief of the bureau, died suddenly of apoplexy on May 8, at his home in Philadelphia. Mr. Walker was born in Ashland, Ohio, in 1829, and his first connection with electrical work was in the capacity of a telegraph operator at the age of 17. He removed to Philadelphia in 1849, where he continued in telegraph work until 1858, when he was appointed assistant superintendent of the police and fire alarm telegraph system of the city. In 1883 he became chief of the bureau, which position he retained until June of last year.

DR. HENRY MORTON, president of the Stevens Institute of Technology, Hoboken, N. J., died May 9, at a private hospital in New York, where he had undergone a surgical operation a few weeks before his death. Prof. Morton was in his sixty-sixth year at the time of his death, and was one of the best known educators in this country. He was a liberal patron of the sciences, and gave thousands of dollars to Stevens Institute. It is a matter of record that he gave $145,000 to this school, and it is known that he gave other large sums which were not made public. He formulated the Stevens curriculum, and ten years later gave the Institute a mechanical laboratory costing $10,000. He purchased with his own private means the apparatus for the study of applied electricity, and personally guaranteed the salary of a professor in this branch. His loss to Stevens Institute is unimaginable. Two sons survive him, his wife having died about a year ago.

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PERSONAL.

DR. SCHUYLER S. WHEELER sailed for England on the steamship "Celtic" on May 9, for a stay of several weeks.

MR. ALFRED B. EDES, formerly manager of the New York office of the Ohio Brass Company, has been appointed sales manager of that company, with headquarters at the main office at Mansfield, Ohio.

MR. G. LAWRENCE BETTS, who has been connected with the New York engineering department of the long-distance service of the American Telephone & Telegraph Company for several years past, has resigned his position there to accept one with the Bunnell Telegraph & Electrical Company of New York.

MR. OTTO W. UTHOFF has resigned his position as representative of the Columbia Incandescent Lamp Company in the eastern states to accept the management of the St. Louis office of the Ohio Brass Company.

MR. BELVIDERE BROOKS, formerly district superintendent of the Western Union Telegraph Company, at Denver, Col., has been appointed general superintendent of the Eastern Division, with headquarters at New York.

MR. N. M. GARLAND has resigned his position as representative of the Emerson Electric Manufacturing Company, in the northeastern states, in order to accept the management of the New York office of the Ohio Brass Company.

MR. C. L. ETHERIDGE, who was for several years assistant chief engineer of the Chicago Telephone Company, has been appointed chief electrical engineer of the Pullman Company, succeeding Mr. D. Avery Kimbark, who has engaged in business on his own account.

MR. DUFFIELD PRINCE, formerly an associate of Mr. W. S. Barstow in the management of the Brooklyn Edison Company's affairs, has left the lighting company to renew his association with Mr. Barstow in the consulting engineering work of that gentleman.

MR. M. C. RYPINSKI, who has been on the laboratory staff of the General Electric Company, at Schenectady, for the past five years, has resigned his position there in order to take charge of the factory of the Empire Electrical Instrument Company, of New York.

MR. PAUL M. LINCOLN has resigned his position as resident electrician for the Niagara Falls Power Company, to accept a responsible position on the staff of the Westinghouse Electric & Manufacturing Company, at Pittsburg, Pa. Mr. Lincoln has made an enviable record for himself at the Niagara Falls plant, where he developed a number of special pieces of apparatus, among which is his now well-known synchronizer.

MR. CALVIN W. RICE, who has been a prominent member of the New York Edison Company's engineering staff for several years, resigned his position there on May 1, to take the position of second vice-president and manager of sales of the Nernst Lamp Company. The members of the meter department of the New York Edison Company, which department was the one to which Mr. Rice gave most of his attention, gathered at Mr. Rice's office just before his departure and presented him with a handsome silver loving cup.

MR. C. VANDEVENTER was tendered a farewell dinner by his office associates and friends at the Hotel Normandie, New York, recently, the occasion being Mr. Vandeventer's leaving the New York office of the Stanley Electric Manufacturing Company to take the management of that company's Chicago office. Among those present were Dr. F. A. C. Perrine, president of the Stanley Company; Messrs. John F. Kelly, M. D. Barr, T. W. Kloman, J. G. Otis, B. T. Hough, C. E. Bibber, L. H. Hobbs, Ray D. Lillibridge, Ward Arnold and Z. V. Taylor.

MR. C. O. MAILLOUX, the well-known consulting engineer, who has been absent for several weeks on a western trip, has returned to New York.

MR. W. B. JACKSON, traveling engineer for the Stanley Electric Manufacturing Company, sailed recently on the "Kronprinz Wilhelm" for an extended European trip.

MR. DANIEL KILLION, formerly connected with Rossiter, MacGovern & Company, has accepted the position of manager for the Charles E. Dustin Company, New York.

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TRADE PUBLICATIONS.

SWITCHES AND PANEL BOARDS. Reading Gas & Electric Fixture Company, Reading, Pa.—A catalogue of all-copper knife switches, panel-boards and tablet-boards built by this company, together with price lists of the standard sizes of switches.

PARALLEL SYSTEM OF ALTERNATING-CURRENT ENCLOSED ARCS. Fort Wayne Electric Works.—This is Bulletin No. 1023, superseding Bulletin No. 1022, and describing the Wood system of alternating-current enclosed-arc lamps and special transformers, designed for operation in parallel for street lighting.

MARINE GENERATING SET. The Holtzer-Cabot Electric Company, Boston, Mass.—This is Bulletin No. 133, devoted to small marine generating sets, launch motors, and accessories. The bulletin also contains descriptions of the Holtzer-Cabot Company's gas engine igniters, one form of which is more fully described in Bulletin No. 136.

THE LITTLE STORY OF A BIG ORDER. Crouse-Hinds Electric Company, Syracuse, N. Y. —This is a collection of *fac-similes* of telegrams which tell the whole story of how the Crouse-Hinds Company obtained a large switchboard order from an extremely particular customer who was determined to have only first-class material—and got it.

ROLLER BEARINGS. Hyatt Roller Bearing Company, Harrison, N. J.—Bulletins Nos. 23 and 24, the former containing a report of the Franklin Institute on comparative tests made with the Hyatt spiral and the ordinary solid steel roller bearings; the latter presents the advantages of the Hyatt roller bearing as used in the form of a bushing for loose pulleys.

BOILERS. E. Keeler Company, Williamsport, Pa.—A well-executed catalogue containing illustrations and descriptions of the complete line of boilers manufactured by this company, which includes horizontal and vertical tubular boilers of the ordinary type, portable locomotive-type boilers, internal furnace or marine-type boilers, and boilers of the water-tube type.

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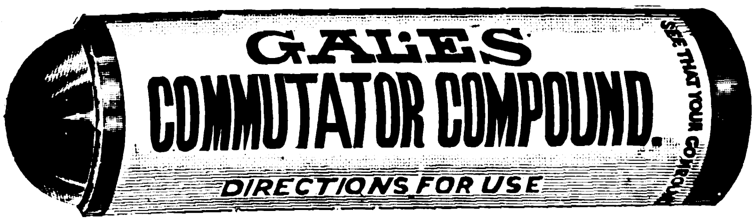

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BELT CONVEYORS. The Jeffrey Manufacturing Company, Columbus, Ohio.—Catalogue No. 67, devoted to the Century rubber-belt conveyor system, and containing illustrations and descriptions in detail of the various parts which go to make up the system.

AUTOMATIC SELF-CONTAINED ENGINES. Skinner Engine Company, Erie, Pa.—Catalogue G, devoted to the well-known Skinner high-speed engines for electric lighting and power duty, and also containing a description of the Skinner system of automatic engine lubrication. The catalogue is beautifully executed, and the description is comprehensive, including many detail illustrations and sectional views.

TELEPHONE INSTRUMENTS AND APPARATUS. Kellogg Switchboard & Supply Company, Chicago, Ill.—This is the Kellogg Company's first general descriptive catalogue, and contains illustrations of the company's complete line of instruments and apparatus, including switchboard parts, slot machines for pay stations, and other special apparatus. The book is handsomely illustrated, and contains views in some representative independent exchanges which have been installed by the Kellogg company.

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BUSINESS NEWS.

UNITED STATES ACCUMULATOR COMPANY, Chicago, has removed its business offices from 951 Marquette Building to 212 East Illinois Street.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, has removed its Chicago office to 79 Dearborn Street, where the company has installed one of the most complete testing laboratories in the west.

THE FALLER AUTOMATIC TELEPHONE EXCHANGE COMPANY, New York, has removed its office from 86 Pine Street to 22 Union Square, east, where the Faller automatic exchange will be exhibited.

THE BUCKEYE ELECTRIC COMPANY, Cleveland, Ohio, announces that recent additions to its factory plant have brought the output up to 10,000 lamps a day, this increase being imperative in order to keep abreast of its orders.

THE CENTRAL ELECTRIC COMPANY, Chicago, announces that it is in position to fill all orders for Westinghouse lightning arresters from stock, so that purchasers ordering from this company will experience no delay.

STANLEY ELECTRIC MANUFACTURING COMPANY has removed its New York office from 71 Broadway to 29 Broadway on account of the necessity for additional floor space due to the growth of the New York office and the inability to obtain additional accommodations at the former location.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, reports recent shipments of Cross oil filters to cities in India, China, Japan, the Philippine Islands, Mexico, Jamaica, Argentine Republic, Belgium and Austria. The company states that these filters are in use in 28 different countries.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has acquired the electric railway equipment business of the Lorain Steel Company, hitherto carried on under the name of the Steel Motor Company at Johnstown, Pa. The Westinghouse Company will continue the works at Johnstown.

NEW ENGLAND MOTOR COMPANY, Lowell, Mass., reports that in order to meet the demand for its well-known dynamos and motors the factory has had to be operated over time for the greater part of the past six months. Among recent orders booked was one for six special 50-hp. six-pole machines for the United States Navy.

THE MASSACHUSETTS FAN COMPANY has removed its factory and principal office from Boston to Waltham, Mass. The new factory is located on Bedford Street, Riverview station, and is in a convenient suburb of the New England metropolis. The city office remains at 53 State street, Boston.

A. W. GUMP, of Dayton, Ohio, formerly manager of the Shelby Cycle Manufacturing Company, has bought the entire contents of that plant, consisting of screw machines, punch presses, lathes, etc. This stock has been moved to Dayton, where it will be offered for sale, except a part of the machinery, which will be used to manufacture special lines of metal goods for the general trade.

THE PHILADELPHIA BOURSE. The annual reports of the officials of the Philadelphia Bourse show a healthy increase in rentals during the past twelve months. There were rented during the year 370 rooms, which is an increase of 32 over the preceding year, and the income from the exhibition space was $18,666, which is $1,685 greater than the income for the preceding year.

SAFETY ELECTRIC SWITCH COMPANY, Providence, R. I., has purchased the plant, patents, and good-will of the Hope Electric Appliance Company of that city, as well as other patents covering improved types of quick-break switches. The company will manufacture instantaneous transfer switches, with and without the center stop; safety quick-make-and-break knife switches for any potential; Hope arc-lamp cut-out boxes, and other specialties.

THE SPRAGUE ELECTRIC COMPANY, New York, has been awarded the contract for furnishing all the electric motors and generators to be used in the cement works of the Atlas Portland Cement Company, Hannibal, Mo., which is the largest cement manufacturing company in the world. The equipment consists of three 400-kw. engine-type split-pole generators and over seventy motors, ranging in sizes from 15 horse power to 125 horse power. The company also received an order recently from the Pennsylvania Steel Company for ten 5-ton electric trolley hoists for use in the new bridge shop at Steelton, Pa. These hoists are of the company's new worm-gear type, which combines extraordinary lifting capacity with remarkably light weight and unusual compactness. They are controlled from a cage, and have a lifting speed of 20 feet per minute.

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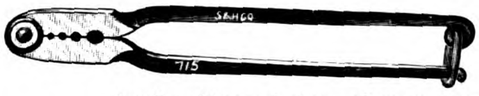

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THE A. G. SCHOONMAKER COMPANY, New York, has recently secured some large orders for second-hand rebuilt machinery, among which may be mentioned 22 trolley and trailer cars, two 250-kw. alternators, 18 pairs of traction trucks, two 120-kw. alternators, and transformers of 400 kilowatts aggregate capacity.

WARD LEONARD ELECTRIC COMPANY, Bronxville, N. Y., notwithstanding the fact that four additions have been made to its works during the past two years, has just made a contract for another addition to its plant. When the present addition is complete the plant will have more than double its capacity of two years ago.

GARTON-DANIELS COMPANY, Keokuk, Iowa, has been compelled to enlarge its manufacturing facilities on account of the increase in business, and is now occupying the building adjoining the old factory building, which is also retained. The company reports that the sales of Garton lightning arresters thus far this year are 40 per cent. greater than for the same period in any previous year.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, recently closed a contract with the Keystone Telephone Company, Philadelphia, for the switchboard for the third district exchange of the Keystone Company. This switchboard will consist of seven sections, giving an ultimate capacity of 3,000 lines. The contract includes all necessary power apparatus and auxiliary appliances.

I. P. FRINK, New York, the well-known manufacturer of lighting fixtures and reflectors, reports among recent export orders the shipment of some large church fixtures to Brazil, Chatham, N. B., Canada; Manila; Vanvouver, B. C.; Bluefields, Nicaragua; Birmingham, England, and Mexico City, Mexico. A large order for shades, special cluster reflectors, and window reflectors, has also been sent to Cape Town, South Africa.

THE FOSTORIA INCANDESCENT LAMP COMPANY, Cleveland, Ohio, announces that it is now turning out 61 different styles of inner globes or envelopes for enclosed-arc lamps. It is the company's policy to manufacture every style of globe for which there is an appreciable demand, with a view to making good its claim that it is headquarters in this line.

THE FELIX F. DAUS DUPLICATOR COMPANY, of New York City, is receiving many strong testimonials concerning the Daus "Tip Top" duplicator, which is used for duplicating typewritten and manuscript letters and documents. This machine is built in several sizes, and is in general use by many prominent corporations, among which are the New York Central & Hudson River R. R. Company, and the Williamsport & North Branch R. R. Company.

CROUSE-HINDS ELECTRIC COMPANY, Syracuse, N. Y., has removed its Cincinnati offices from 405 Union Trust Building to 234 West Fourth Street, where much more commodious quarters will be had. The new quarters will be made the distributing point for Ohio, Southern Indiana, Kentucky, Tennessee, Mississippi and Alabama, and a large stock of switches, panel boards, and Syracuse head-lights will be carried in stock there.

PITTSBURGH GAGE & SUPPLY COMPANY, Pittsburg, Pa., has been obliged to again enlarge the filter department of its business on account of the demand for White Star oil filters. The company has devoted the entire third floor of its new factory building to the manufacture of these filters, and the greater part of the second floor will be occupied by a large stock of all sizes of White Star filters, so that prompt shipments may be made. The company has been appointed representative of the Weller Manufacturing Company, Chicago, for its line of elevating, conveying, and power-transmitting machinery.

BROWN-CORLISS ENGINE COMPANY, Corliss, Wis., reports an excellent business in heavy-duty Corliss engines. The company is now at work on engines for J. B. King Company, New Brighton, Staten Island; the Roosevelt Hospital, and the Hall of Records, New York City; The Edison Electric Light & Power Company, Erie, Pa.; the Standard Underground Cable Company, Perth Amboy, N. J., and other representative establishments. This company makes a specialty of quick delivery, and its shops, which are equipped with the most modern tools, are capable of turning out about $1,000,000 worth of work a year.

HAZLETON BOILER COMPANY, Rutherford, N. J., reports a brisk demand for its product. Among orders recently received were the following: two 100-hp. boilers for the Alabama Tube & Iron Company; one 250-hp. boiler for the electrical department of the Brookline, Mass., Gas Light Company, making a total of 1,000 horse-power at this plant; one 400-hp. boiler for the Apsley Rubber Company; three 450-hp. boilers for the Carlton Paper Mills; five 1000-hp. boilers for the Brooklyn, N. Y., Union Gas Company; a 235-hp. special boiler for the North Adams, Mass., Gas Light Company, and three 750-hp. boilers (repeat order) for the Farrell Foundry & Machine Company.

AMERICAN SCHOOL OF CORRESPONDENCE, Boston, and **THE ARMOUR INSTITUTE OF TECHNOLOGY,** Chicago, have arranged to co-operate in technical educational work, arrangements having been made whereby the professors and instructors of engineering of the Armour Institute will constitute a board of instruction, revision and examination for the American School of Correspondence. The work done by the students of the correspondence school will be duly accepted and credited at the Armour Institute when students desire to complete their course there and take a degree, and all examination papers from correspondence students in the vicinity of Chicago will be reviewed and corrected by members of the Armour Institute faculty.

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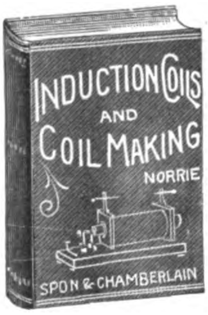

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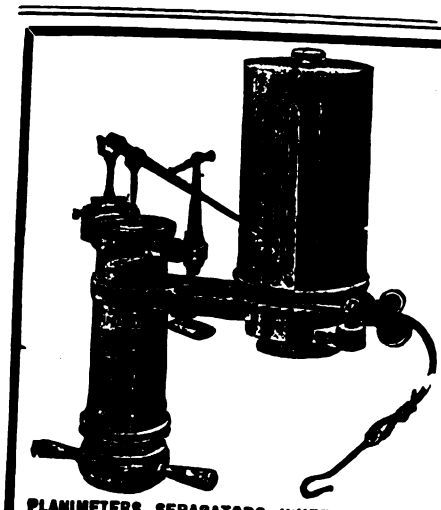

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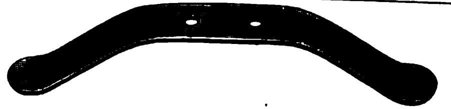
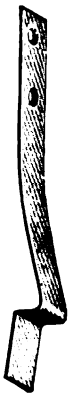
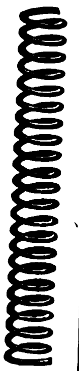

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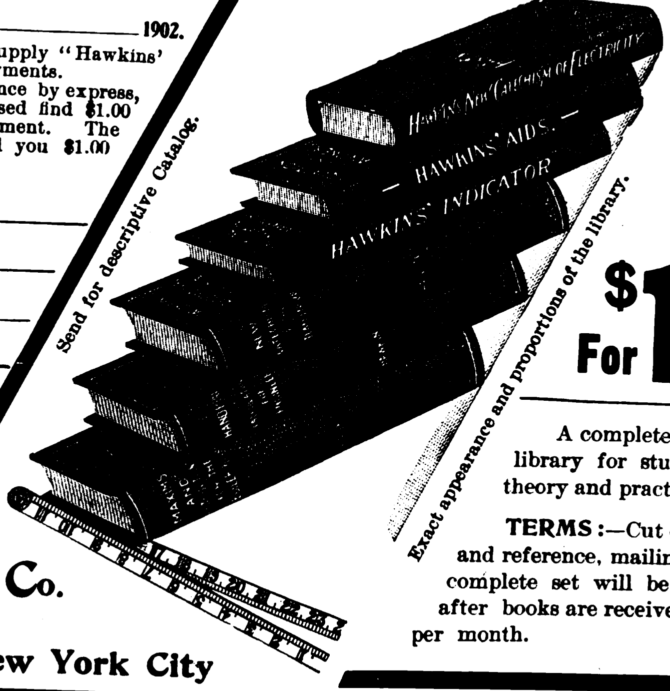
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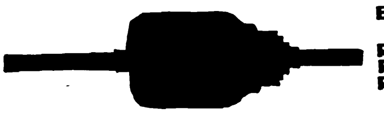

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Vol. XIV. New York, July, 1902. No. 7.

A MODERN DISTRICT-SUPPLY CENTRAL STATION.

PLANT OF THE CENTRAL ELECTRIC COMPANY AT METUCHEN, N. J.

The modern tendency toward centralization in electric light and power work made feasible by the high voltages generated and transmitted, and the consequent saving accruing from the operation of such a centralized plant furnishing electrical energy to all of the towns within a considerable radius, are well exemplified in the plant recently erected by the Central Electric Company at Metuchen, N. J. The station supplies current to Metuchen, Highland Park, New Brunswick, Perth Amboy, Rahway, Woodbridge, Bound Brook and Dunellen; and its erection involved the consolidation of the Middlesex Electric Company, Edison Electric Illuminating Company of New Brunswick, Raritan Electric Light & Power Company, Rahway Electric Company and the Bound Brook Electric Light, Heat & Power Company.

An idea of the economy of operation which must have necessarily followed this particular consolidation may best be obtained by considering the equipment which the plant at Metuchen replaced. At New Brunswick there were Edison bipolar machines belted from a countershaft driven by belt from simple Corliss type engines. The plant at Perth Amboy was equipped with 1100-volt single-phase alternators and American (Wood) arc machines belted from a countershaft driven by a belt from simple high-speed engines. The apparatus at the Rahway plant consisted of single-phase 2200-volt, 125-cycle alternators and 500-volt railway generators, all belted from high-speed engines. The Bound Brook Company was operating an 1100-volt two-phase alternator belt-driven from a Corliss engine. Moreover, the location of all of these plants was such that it was necessary to cart all of the coal used, at a cost of 28 to 40 cents per ton, and in every case except the plant at Bound Brook to purchase the water for boiler supply.

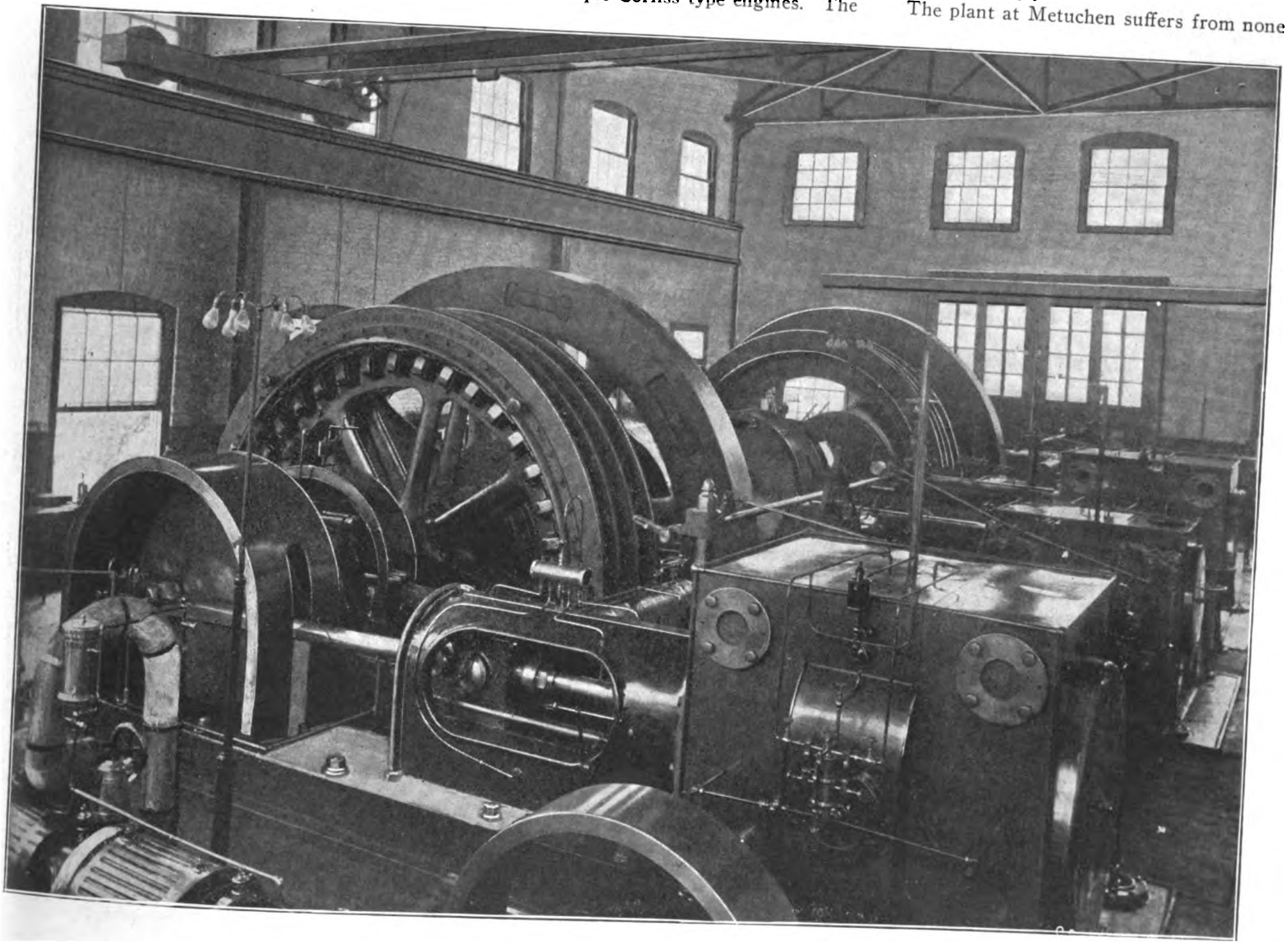

FIG. I.—DIRECT-CONNECTED, THREE-PHASE ALTERNATORS IN THE ENGINE ROOM.

The plant at Metuchen suffers from none of these drawbacks; water is plentiful, and coal easy of access. A plan view of the station is given by Fig. 6 herewith, and Fig. 4 is a view of the boiler room. Steam is generated in two Morrin Climax vertical water-tube boilers of 600-h.p. each made by the Clonbrook Steam Boiler Company of Brooklyn, N. Y. The evaporative capacity of each boiler is 18,000 lbs. of water pei hour on a guaranteed coal consumption of one pound of coal for every 10½ lbs. of water evaporated. Each boiler has a stack 60-ins. in diameter and 75 ft. high erected on top of the boiler casing. Space is reserved in the boiler room for an additional unit similar to those already installed, the foundation for which has already been laid.

The boilers are hand-fired with a mixture of buckwheat and bituminous coal. The fuel is carried into the station from a siding of the Lehigh Valley Railroad at Perth Junction up a trestle to a track over the coal storage bins, which are near the furnace doors, as indicated in Fig. 2. The boiler water supply may be taken from any one of three sources; a spring-fed brook, three 100-ft. artesian wells and the regular town supply. At one end of the boiler room in a separate compartment are two 6 x 9 x 5¼ x 10-in. duplex feed-water pumps, made by the Buffalo Steam Pump Company, of North Tonawanda, N. Y. The water is first pumped into a large tank above the office, which supplies a 1250-h.p. "vacuum" feed-water heater made by Warren Webster & Co., of Camden, N. J., and from the heater it is pumped directly into the boilers. As the piping to the boilers is in duplicate, either of the pumps may be used to feed directly into the boilers or discharge into the tank. The feed-water heater is fed by the exhaust from the two exciter units and the circulating and air pumps. The working steam pressure under full load is 125 lbs. and under light load 80 lbs.

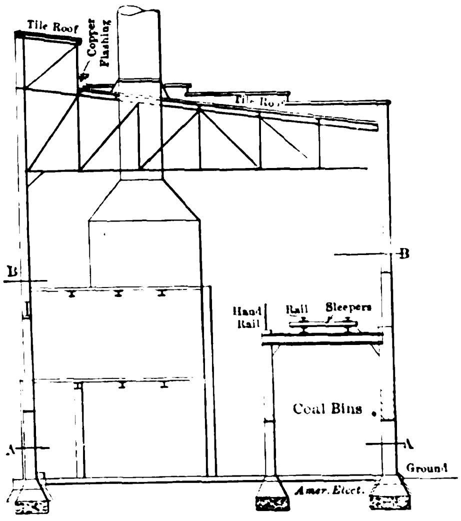
Tile Roof
Copper Flashing
Tile Roof
B
B
Head Rail
Rail
Sleepers
Coal Bins
A
A
Ground
Amer. Elect.

FIG. 2.—SECTIONAL ELEVATION OF BOILER ROOM.

The main units in the engine room are two horizontal cross-compound condensing engines built by the Pennsylvania Iron Works Company of Philadelphia, Pa., and directed connected to two 500-kw. three-phase, 60-cycle, 6600-volt electric generators, built by the Stanley Electric Manufacturing Company, of Pittsfield, Mass. A general view of the engine room equipment is given in the front page illustration. The principal dimensions of the engines are as follows:

Diameter of High Pressure Cylinder	24 ins.
Diameter of Low Pressure Cylinder	44 ins.
Length of Stroke	42 ins.
Diameter of Crank Shaft	20 ins.
Diameter of Piston Rods	4½ ins
Diameter and Length of Cross Head Pins	6 ins.x8 ins.
Diameter and Length of Crank Pins	8 insx8 ins.
Length of Main Bearings	32 ins.
Wearing Surface of Cross Head	260 sq. ins.
Diameter of Fly-wheel	18 ft.
Diameter of Steam Pipe	8 ins.
Diameter of Exhaust Pipe	14 ins.
Weight Complete	285,000 lbs.

Both the high and the low-pressure cylinders are lagged with pure magnesia and are steam-jacketed, and the ends of the cylinders are fitted with relief valves. The cylinder heads are turned so as to leave a clearance space between the piston body and cylinder heads of 5-16 in. on the crank end and 3-16 in. on the head end. The valve gear of the engine was fully described in the June number of this paper, and hence does not call for description here. The pistons are made of semi-steel heavily ribbed inside and are provided with followers, bull and packing rings, and also special anti-friction rings for the low-pressure piston. The piston rods are made of open hearth forged steel, turned and finished, and are threaded at each end, one end being fitted to screw into the cross-head, of course, and the other to receive the lock nut for the piston. A collar is forged solid on the rod to

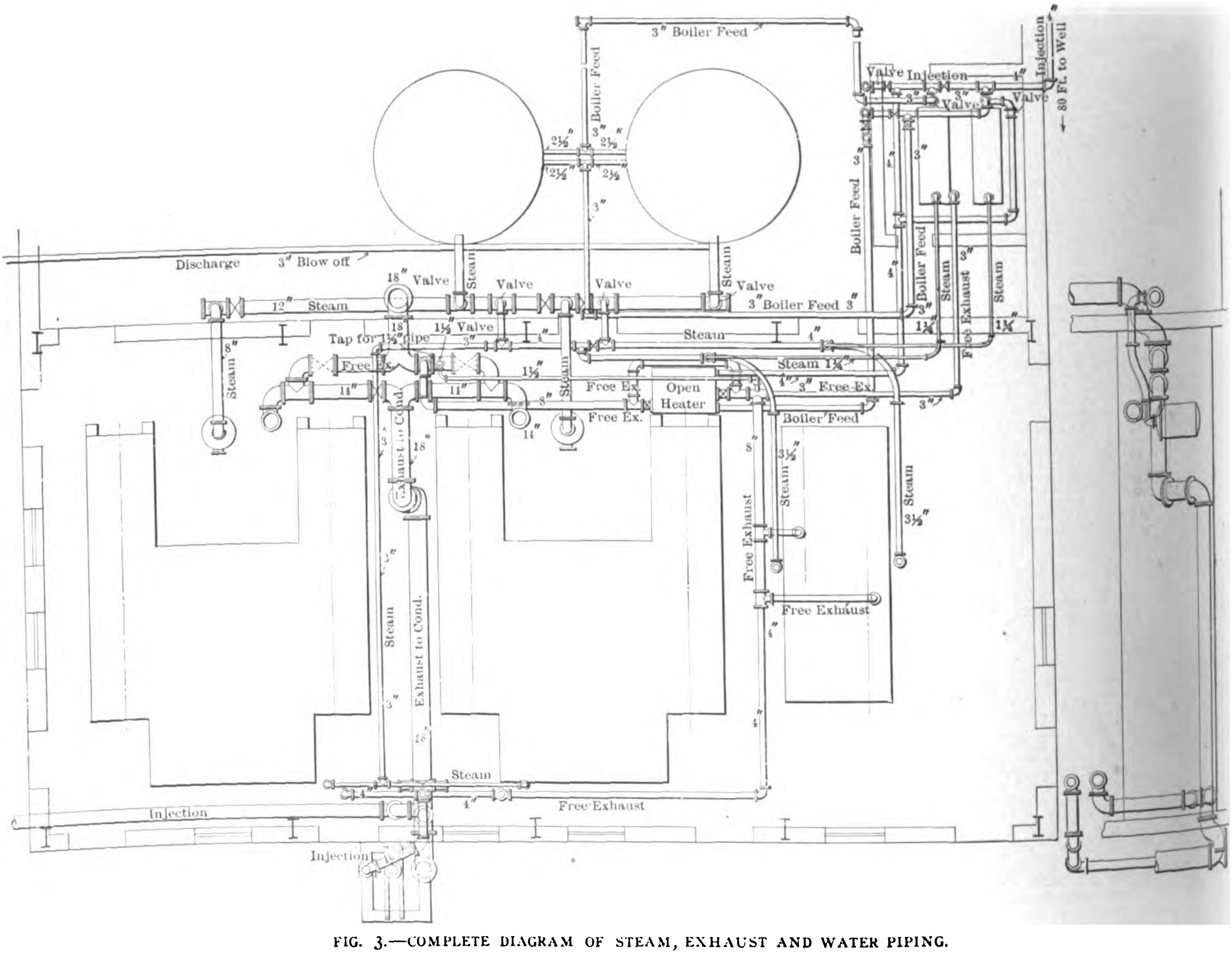
3" Boiler Feed
Boiler Feed
Injection
80 Ft. to Well
Valve
Injection
Valve
Valve
Boiler Feed
Boiler Feed
Steam
Free Exhaust
Steam
Discharge
3" Blow off
18" Valve
Steam
Valve
Valve
Steam
Valve
12" Steam
3" Boiler Feed 3"
Tap for 1½" pipe
1½ Valve
Steam
Free Ex.
Steam
Free Ex.
Open Heater
Free Ex.
Steam 1½"
3" Free Ex.
Boiler Feed
Steam
Free Exhaust
Steam
Free Exhaust
Exhaust to Cond.
Steam
Exhaust to Cond.
Steam
Free Exhaust
Injection
Injection

FIG. 3.—COMPLETE DIAGRAM OF STEAM, EXHAUST AND WATER PIPING.

form a shoulder against which the piston is forced. Metallic packing is used in each of the piston-rod stuffing boxes. A solid bottom is cast in the crank pit of the bed frame which serves as a drip reservoir whence the oil is led away in pipes.

Special attention is paid to the fact that these engines are to be used in the operation of three-phase generators in parallel, and the speed regulation is accordingly such that under similar conditions of load the several generators will be driven at precisely the same frequency. An auxiliary regulator is also used in combination with a rotating valve provided under the high-presure cylinders for use in emergency, and so arranged as to entirely cut off steam should the normal speed be exceeded by two revolutions. The flywheel is of the segmental type weighing approximately 45 tons and is made of cast-iron; it was finished up with the shaft running in its own bearings.

The cylinders of the engine are lubricated by double sight-feed Seibert lubricators of ½-gallon capacity arranged in combination with Musgrave columns. An independent system of Lonergan hand pumps of one-quart capacity is also provided. Adjustable sight-feed manifold tank oilers are provided for the main bearings and guide barrels, and the crank pins are provided with an automatic centrifugal oiling device. All of the other moving parts are oiled from sight-feed lubricators.

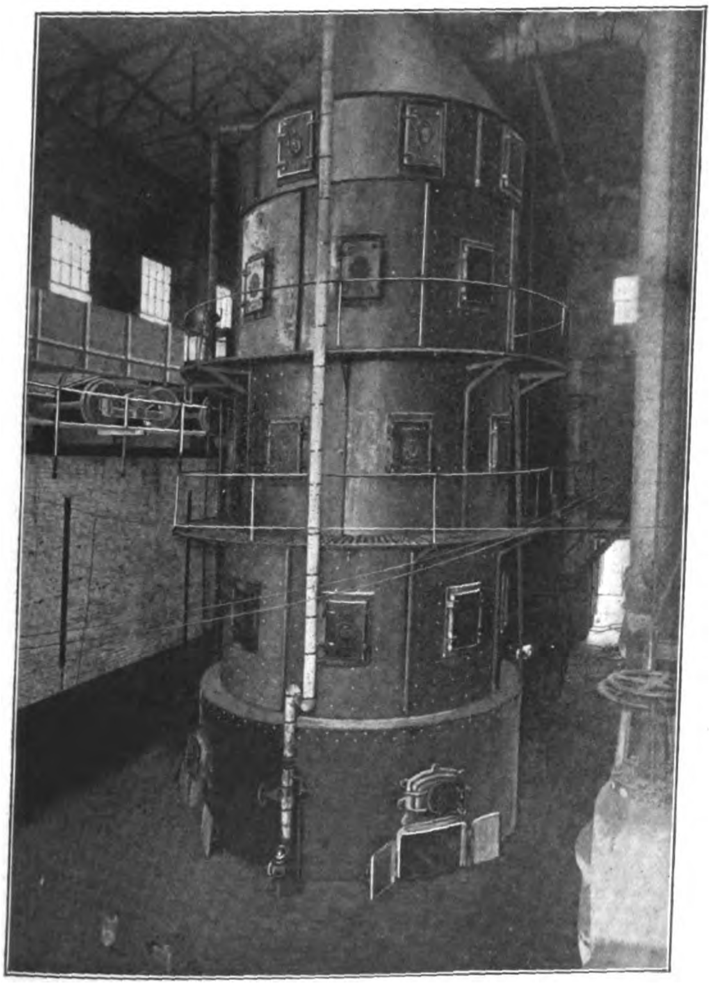

FIG. 4.—VIEW IN BOILER ROOM.

Each engine is provided with a receiver of the vertical type, which connects with the exhaust from the high-pressure cylinder at its lower end and with the steam supply pipes for the low-pressure cylinder at its upper end. Straight-way gate valves are placed in the pipes leading from the cylinders to the receiver and suitable connections to the low-pressure cylinder are provided so that either side of the engine may be operated independently of the other. The receiver and the piping between it and the cylinders are covered with plastic magnesia. A pop safety valve is provided to control the pressure in the receiver and a trap removes the water of condensation. The main throttle valves for the high and low pressure cylinders are located beneath the floor, and polished stands and hand wheels are provided for both the main and the by-pass valves. The by-pass of the low pressure valves is geared across to the high pressure side of the engine, making one large and two small stands and hand wheels on the high pressure side. The low pressure side is provided with three similar stands, the larger one connecting with the low pressure throttle valve, and the other two to valves on the drip pipe system. The piping is arranged so that either side of the engine can be run as a single cylinder engine, and either condensing or non-condensing.

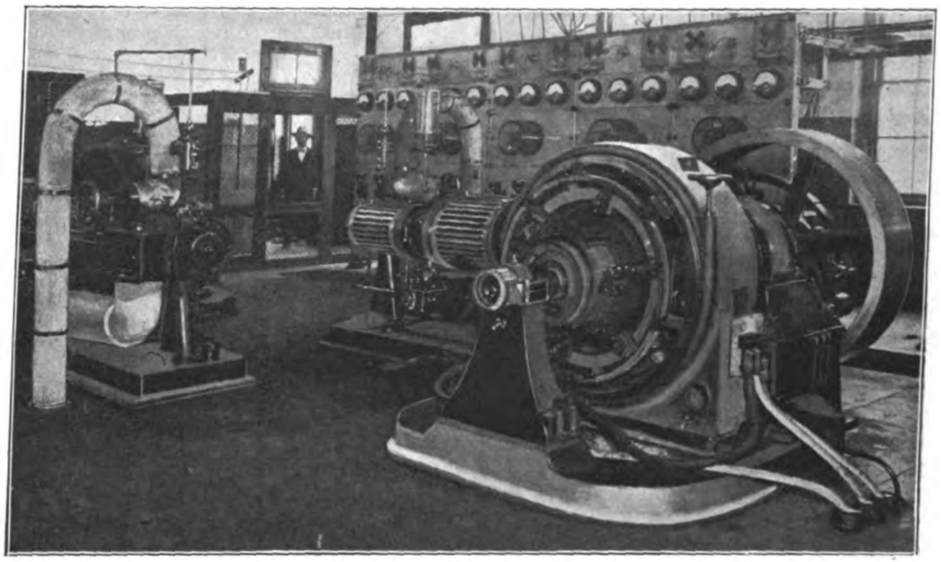

FIG. 5.—VIEW OF THE EXCITER UNITS.

The low-pressure cylinder is provided with an automatic reducing valve capable of reducing the steam pressure from 145 to 60 lbs. or less as occasion may require. An automatic valve is provided between the low pressure cylinder and the condenser so as to allow of a free exhaust to the atmosphere in case of accident to the condenser or when running non-condensing. The engines are supplied with a complete oiling system whereby all of the waste oil is brought to a 200 gallon oil filter, made by M. A. Turner, of Chicago, and purified for use again.

The condensing outfit was installed by Henry R. Worthington, and consists of an 18-in. elevated condenser, shown diagrammatically by Fig. 8, an 8 x 12 x 12 x 10-in. compound circulating pump, an 18-in. entrainer, and a 6 x 12 x 12-in. rotative dry vacuum pump. The outfit is capable of condensing the exhaust of a 1200-h.p. plant.

Condensing water is obtained from three brooks which supply an artificial lake and to which lake the hot well discharge may be returned in case of shortage of water. The piping is also arranged so that water may be drawn from three artesian wells for condensing purposes, and although this latter arrangement would not yield sufficient water for condensing purposes, the low temperature of the water thus acquired reduces considerably the amount of brook water necessary to run the plant condensing. The complete system of steam and water piping is shown by Fig. 3 herewith.

The Stanley generators have a capacity of 500 kilowatts each when operated at a speed of 100 r.p.m. They supply current at 60 cycles per second and are wound to give their rated output at a maximum e. m. f. of 7000 volts, with a range of voltage of from 6200 to 7000. The armature coils are insulated from the frame so as to stand a potential of 20,000 volts alternating current for one minute and the field coils are insulated to stand a potential of 1000 volts alternating current for one minute and also to withstand a sudden opening of the exciting circuit when carrying full excitation. The ultimate rise in temperature in any part of the machine after a continuous run of 24 hours at its full rated non-inductive load is guaranteed not to exceed 40 degrees Centigrade above the surrounding air of 25 degrees Centigrade, after a two-hour run at 25 per cent overload immediately following the 24-hour run.

The regulation of the generators without the aid of compound windings or any extraneous devices is such that the rise in voltage from full load to no load when operating at 6600 volts is not over 8 per cent, and the drop in voltage from no load to full load when operated at 7000 volts does not exceed 9 per cent. The commercial efficiency at full rated non-inductive load is 93 per cent; at three-quarters load it is 92 per cent; at one-half load it is 90 per cent, and on quarter overload it is 93 per cent. The total amount of energy required to excite the fields of each generator at full load with a power factor of unity is 9.6 kilowatts. With a power factor of 90 per cent the energy required is 11 kilowatts, and with a power factor of 80 per cent, the energy required to excite the fields is 11½ kilowatts.

Two 50-kilowatt, 125-volt Westinghouse generators are installed as exciters, and each is direct-connected to a Ball & Wood tandem-compound engine making 275 r. p.m. A view of the exciter units is given by Fig. 5. The full load efficiency of the exciter generators is 90 per cent and they are overcompounded from 110 volts at no load to 115 at full load.

The switchboard, a view of which is given by Fig. 9, was installed by the Stanley Electric Manufacturing Company, and all of the high-tension switches on the board are of the oil type and of double the carrying capacity required for either the generators or the circuits. The main switchboard is of blue Vermont marble and contains two main generator panels and five circuit panels. The mains from one of the circuit panels lead to another part of the building to a set of Stanley three to two-phase step-down transformers having a ratio of 6600 to 2300 two-phase, at which pressure the current is distributed for local lighting. The high-tension leads from the other four panels are carried through lightning protection devices to sub-stations at New Brunswick, Perth Amboy, Rahway and Lincoln, the latter supplying the Bound Brook district. General Electric short-gap arresters with Stanley dischargers are used on all of the feeders.

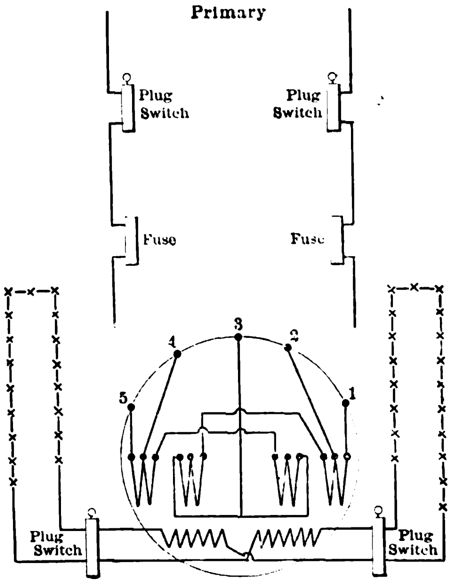

FIG. 7.—DIAGRAM OF TRANSFORMER CONNECTIONS.

The transmission line is of the most substantial construction throughout, the insulators used being 10,000-volt Hemingray glass. The feeders vary in length from 4½ to 9½ miles and are given two transpositions at respectively one-third and two-thirds of the distance covered by each particular feeder.

All feeders are carried overhead with the exception of those at New Brunswick. These are carried on 'the stone work of a bridge over the Raritan River, then down through a triple-conductor, steel armored submarine Okonite cable under the Delaware & Raritan Canal, which parallels the Raritan River at this point. On the opposite bank of the canal the line is carried underground in vitrified conduits through Okonite single-conductor lead-covered cable, each in a separate conduit, to the substation, which is about 550 ft. distant. The entire underground and underwater system is provided with oil switches and is in duplicate, thus making it possible to carry the whole load on either set entirely independent of the other in case of accident.

The sub-station at New Brunswick has in-

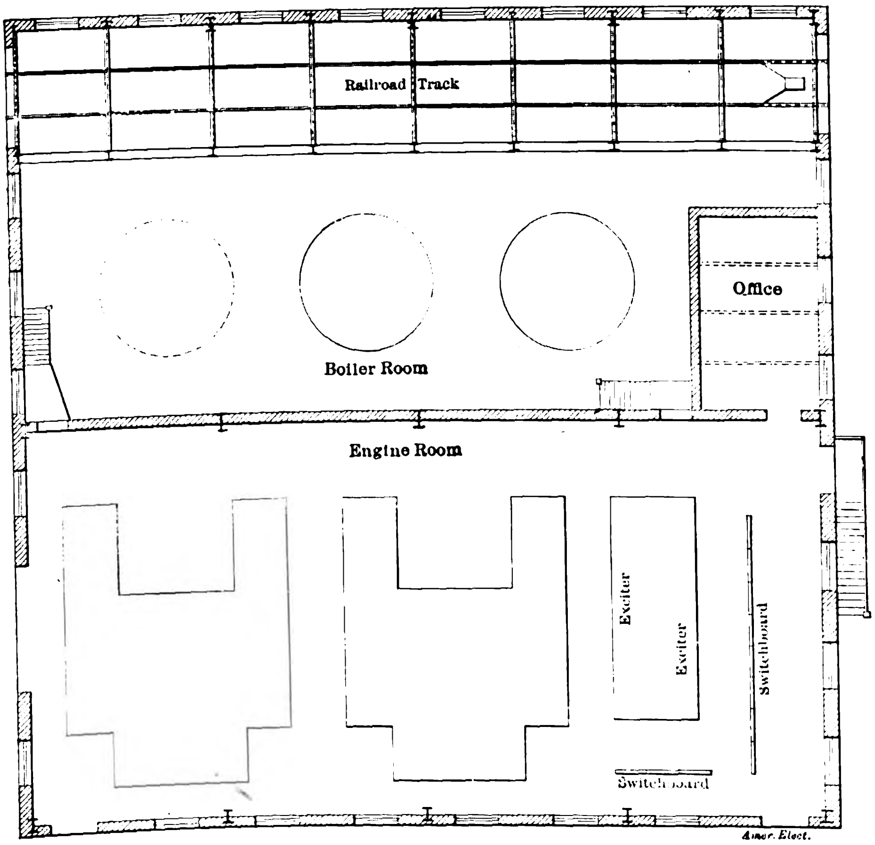

FIG. 6.—PLAN OF THE CENTRAL ELECTRIC STATION AT METUCHEN.

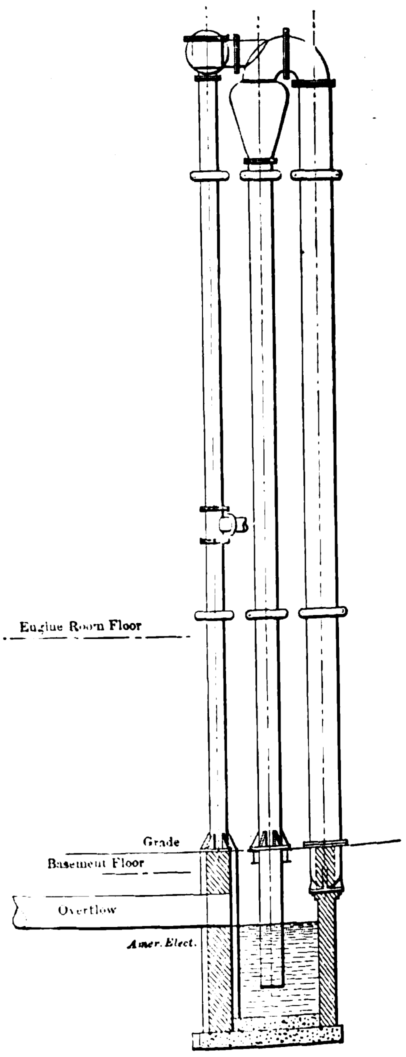

FIG. 8.—ELEVATION OF CONDENSER.

stalled at present, one 100-kilowatt set of step-down transformers for lighting, and one 200-kw., 250-volt Westinghouse rotary converter for supplying the Edison three-wire system. Space is, however, reserved for doubling this equipment, which will be installed in the near future.

At the Perth Amboy sub-station there are at present two 100-kilowatt Stanley step-down transformers, 6000-volt three-phase to 2300-volt two-phase, and three General Electric constant-current transformers for street lighting circuits, each transformer having a capacity of 50 6.6-ampere enclosed arc lamps. The primaries take the current directly from the three-phase transmission working three-to-two-phase or straight single-phase as desired. Fig. 7 is a diagram of the method employed. For single-phase the lines 1 and 5 are connected together. For three-phase combinations, *i. e.*, three-to-two-phase, number 4 of the teaser transformer is connected to number 3 of the main transformer and the lines are connected to number 2 of the teaser and to numbers 1 and 5 of the main transformer. The three transformers now installed are connected in single-phase, but with the addition of a fourth transformer, the three-to-two-phase connection will be used whereby a balance of the transmission will be obtained independent of the number of transformers installed.

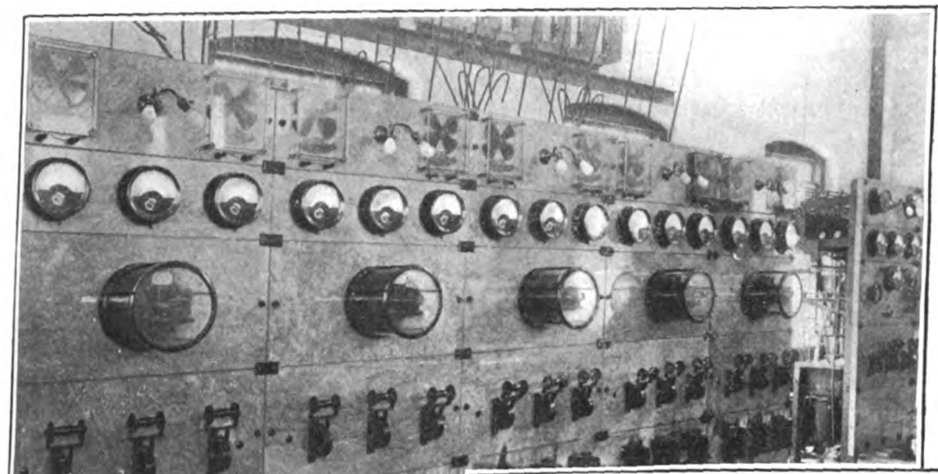

FIG. 9.—FRONT OF SWITCHBOARD.

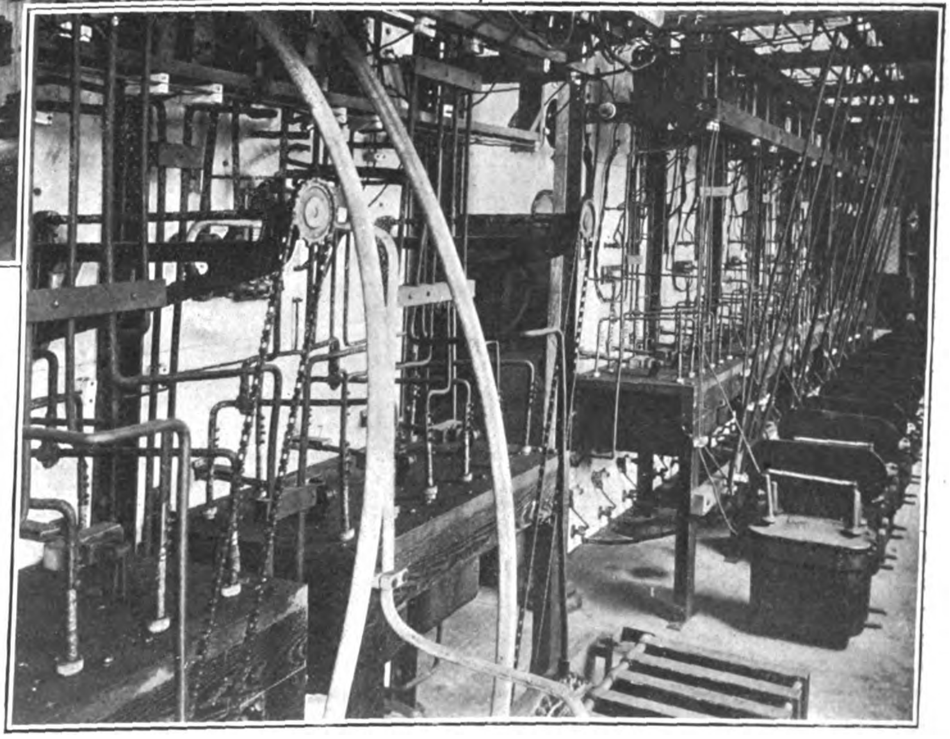

FIG. 10.—REAR VIEW OF SWITCHBOARD.

The equipment at the Rahway sub-station is similar to the equipment at the Perth Amboy station, with the exception that there are no constant-current transformers, and with the addition of a 220-kw., 550-volt Westinghouse rotary converter for supplying the current for the Rahway street railway. The Lincoln sub-station contains one 100-kw. set of Stanley step-down transformers similar to the others, and three reactive-coil General Electric series regulators for the incandescent street lighting system.

The main generating plant at Metuchen was designed by the general manager, Mr. Dudley Farrand, and his assistant, Mr. Paul C. Oscanyan, to both of whom we are indebted for courtesies extended.

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NOTES ON THE ELECTRICAL AND MECHANICAL EQUIPMENT AT THE CHARLESTON EXPOSITION.

BY J. H. GRANBERY.

The installation at Charleston presents an unusual feature in this class of work in that there is no regular power house or generating station on the Exposition grounds. All of the current for lighting and power purposes is brought from the power house of the Charleston Consolidated Railway, Gas & Electric Company to a sub-station inside the grounds, and from there distributed over the various lighting and power circuits. The power house is about a mile from the main entrance and two three-phase three-wire circuits are brought from it on a pole line to the sub-station in the Auditorium Building. The potential is 2300 volts and the frequency 60 cycles.

The main switchboards and controlling apparatus with oil-break switches for manual operation are located in the upper story of the building, and a vertical well through which the lines are carried on porcelain insulators affords a ready means of access to the transformer station in the basement. The main transformers are four in number, of the General Electric type R, each of 60 kilowatt capacity, cooled by air blast. They are connected, one transformer in each phase, and one in reserve; but have been used with two transformers in one phase, and one in each of the other two phases. These supply current for operating the arc lights in the Plaza, the Sunken Gardens, and in the general illumination of the buildings and grounds.

The sub-station equipment includes, besides these transformers, a Laidlaw-Dunn compressor with capacity of 140 cubic feet of free air per minute, belt-driven by a 25-h.p. 500-volt Crocker-Wheeler motor. Air from this compressor operates a pump supplying air to the bellows of the grand organ in the Auditorium. This was made by the Bishop & Babcock Company, Cleveland, Ohio, and operates in the same manner as a direct-acting steam-pump, thus being capable of extremely close and accurate regulation. A Deane triplex pump 7-ins. x 8-ins., belt-driven by a Wagner single-phase motor of 5 horse-power operating at 104 volts; and a motor generator of the General Electric make, consisting of a four-pole 75-h.p. motor operating at 500 volts direct-connected to a four-pole 65-kw. generator giving 125 volts at full load, complete the equipment. The measuring instruments are of the Thomson type.

There is another sub-station in the Machinery Hall comprising part of the General Electric Company's exhibit. It contains a 500-kilowatt rotary converter furnishing direct-current at 500 volts, which is supplied with current from the same source as the rest of the Exposition. A 500-volt direct-current feeder from the power house is used for starting, as this is done from the direct-current end. The rotary is operated through air-blast transformers with a motor-operated blower, the company's standard switchboard panels and oil switches. Its current is used for operating most of the 500-volt motors about the grounds.

The majority of the motors supplying power for the various exhibits are of the Wagner single-phase type; they are operated on individual phases of the three-phase system. In the Commerce Building a Holtzer-Cabot motor-generator set is used to generate a 16-volt current for 200 small lights in a model of a factory and packing plant. In the same building motors are used for driving loom machinery, printing presses and type-setting machines.

The pumping station on the grounds is equipped with one 85-h.p. and one 40-h.p. return tubular boilers supplying steam to two Blake pumps, each 15 x 12 x 18-ins. These supply the fountains as well as the fire tanks and the general plumbing system, salt water being used for this purpose. An elevated tank with a capacity of 50,000 gallons is supplied by air-lift from an 8-inch well about 600 feet deep for furnishing fresh water.

Lake Jaunita is fed from the Ashley River by tide gates automatically operated. A centrifugal pump is provided direct-connected to a vertical engine. It has a capacity of 10,000 gallons per minute and is used to replenish the lake supply in case of leakage or low tides.

The Fisheries Building is supplied with salt water from the Ashley River by a Deane vertical duplex pump working against 1000 feet of suction, with a 10-foot lift, and discharging against 30 pounds pressure; it supplies 100 to 150 gallons of salt water per minute and is belt-driven by a 5-h.p. General Electric direct-current motor operating at 500 volts. A sand filter is used to purify the water and a safety valve to keep the pressure constant. An ice machine of the Remington type is operated by a General Electric 15-h.p. direct-current motor operating at 500-volts and is used to keep the temperature of the water in the tanks constant. Air is discharged into the tanks under very light pressure. It is pumped by means of salt water taken from the regular fire mains, and operating a pump similar to the one that operates the bellows in the Auditorium Building. Its action is very regular and is under the most exact control, so that minute variations may be made in the air pressure. Ordinarily from 9 to 10 pounds is the pressure carried, and the air is discharged at the bottom of the tank through a glass tube drawn to a point.

In the Mining and Forestry Building a very fine exhibit of electric furnace products is shown. A large and extremely beautiful specimen of amorphous silicon carbide and several smaller specimens showing partially converted masses, illustrate the production of carborundum. Granular, flake and lump graphite are shown and comparative specimens showing difference in the structures due to the difference of pressure in natural and artificial forms. Graphite electrodes and anodes produced by the electrical furnace are shown, as is also graphite made from anthracite coal and aluminum by direct reduction with carbon.

In the South Carolina Building is shown a 7-kilowatt three-phase rotary converter designed and built by students of Clemson College, an institute supported by the State of South Carolina, and illustrating the progress manual training has made in this district. The Negro Building also contains much work of the same character made by students of the various industrial schools, one vertical engine of 12 horse-power is especially noteworthy in this respect. This building also contains an electrically-operated machine gun of one-inch bore, the invention of one of this race.

In the Government exhibits electric motors are used for driving the coining press, and a gas engine drives a blower for a fog horn in the Lighthouse Board exhibit. The Patent Office exhibit shows many of the older and more interesting relics, especially in the electrical field. Notably among these are models of the duplexing and quadruplexing telegraph instruments, a model of the original Thomson-Houston arc light dynamo, a reproduction of Henry's electromagnetic motor, and the Davenport motor, the first ever patented. A model of the original Edison dynamo is also shown, as is a model of the Thomson electric welding apparatus, and various arc light dynamo regulators of the early type.

Much of the lighting, especially of the bridges, throughout the grounds, is done by acetylene, and the generators are in most cases placed at the extremities of the bridges illuminated and operated as exhibits. The lighting as a whole is not on the same magnificent scale attempted in previous expositions in this country. There is no concentration at any point, but it is carried out in a delicate manner by using it as a means of accentuating the architectural features of the buildings, and of outlining the various portions of the grounds. The lights at night form a very good map of the grounds, as their grouping is so arranged as to bring out the features of the portion in which they are installed. The lighting of the Sunken Gardens especially is arranged most beautifully. The incline from the buildings to the lake in the center of the Gardens is such that one standing in the pathway on either side sees the building upon the opposite side and its reflection in the water at the same time. The effect is very pleasing. Searchlights are operated from the conning tower on top of the Music Pavilion.

Direct current is distributed through the grounds at 500 volts. For the alternating circuits, with the exception of arc lighting, current is taken from the sub-station at its initial voltage and transformed at the point where used. Most of the wiring is laid underground in wooden conduits formed of 2-in. x 4-in. timbers with a groove cut in the top. The lead-encased cable is laid in this groove and a board placed over the top, thus forming a one-duct conduit. Where the alternating current lines are brought above the ground, a staging is built directly over the box into which the line is brought at the end of the conduit. The platform on this staging serves as a floor to support the transformers, and as a roof to prevent moisture entering the box below. One transformer is connected in each phase and lightning arresters in each circuit.

The arc lamps about the Plaza are carried on poles with ornamental bases, two lamps to each pole; the wiring is brought above the surface through an iron pipe and connected with the conduits under the asphalt pavement. All arc lamps are of the Thomson enclosed type, series alternating, of 1200 candle-power. They are arranged in eight circuits of fifty lights each.

General Electric type H transformers are used to supply current to the incandescent lights. They are placed upon or near the building to be illuminated and the high voltage mains are run, whenever practicable, under the buildings to save the expense of conduits. The lamps are placed two feet apart along the windows, cornices, and other outlines of the buildings. In the Sunken Garden the lights used are colored. All circuits are fused separately, and where the distribution is underground the cables are lead encased and laid in wooden conduits.

To Mr. Charles T. Malcolmson, Chief Engineer of the South Carolina Interstate and West Indian Exposition, is due the credit for the artistic lighting effects and the solution of the various engineering ing problems, as well as the writer's thanks for the courtesy which made the collection of this data possible.

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Working Vulcanite.—As is well known, vulcanite, or ebonite, is greatly used in electrical industries on account of its high insulation resistance, as well as for the better finish which can be given to it; and although many articles come from the factory in a finished state, it is met with in the workshop mostly in the form of rods and sheets, and must be worked with the same tools as are used for working metals. The best qualities show on fracture a lustre something of the nature of jet, and the poorer qualities show a corresponding dullness. Although easy to machine, it is hard on tools; and in sawing, turning, planing or milling the best speed is that at which brass is machined, and milling should always be accompanied by a free use of soap and water. In turning or sawing, lubricants should be avoided, on account of the spattering around of ebonite cuttings and soapy water.

Twenty-Fifth Convention of the National Electric Light Association.

The twenty-fifth convention of the National Electric Light Association, held at the Grand Hotel, Cincinnati, was called to order at 10.20 a. m., May 20, by president Henry L. Doherty. Gen. Hickenlooper, president of the Cincinnati Gas & Electric Company, welcomed the convention to Cincinnati in the name of the city's chief executive, who was absent from the city, and spoke of Cincinnati's importance as a manufacturing center. Out of the half million residents of the city, he said, 200000 are engaged directly in manufacturing. Referring to the large factories, the growing importance of the Bullock Electrical Manufacturing Company in the electrical field was pointed out eloquently. In conclusion, the speaker expressed the wish for a profitable convention.

Past-president Fred Nicholls, of Toronto, Canada, responded to the address of welcome in behalf of the Association. He said that the Association had never assembled in any city where so great and varied entertainment was promised, and he extended a cordial vote of thanks in the name of the body. President Doherty then made a few preliminary announcements.

An unusual feature was inaugurated at this convention—that of a "question box," comprising inquiries and requests for information and opinions on practical subjects pertinent to plant operation, and the president urged a general response to questions in the question box. Fully 80 per cent of the members he considered capable of giving advice on some special topics, and their contributions were especially needed for answering question-box inquiries. He then delivered the president's address, which was unusually strong in the way of profitable suggestion, for both the industry and the Association.

As to municipal ownership, Mr. Doherty remarked very shrewdly that the efforts of its advocates were productive of the very thing they most wished to avoid, namely, the formation of large syndicates for the control of the private properties, which were able thus to protect themselves against raids of all kinds. He advocated work by the Association and by individual members against the movement, and recalled the effort made to bring the League of American Municipalities to time in making an investigation of a number of municipal plants. If this could not be forced, possibly the American Economical Society, whose members came largely from academic professors and had a sincere but unpractical view of the subject, might be induced to join with them in such an investigation. The fact remained that 90 per cent of the municipal plants were rank failures, and it only remained to demonstrate the true conditions.

Concerning central station rates and methods of charging he said that the efficiency of lines, meters and transformers in alternating-current stations are often so low that the stations receive pay for only 35 to 65 per cent of the current sent out, and even then the cost of wasted current is not as great as the additional interest charges in direct-current stations. He argued that these losses should be covered by fixed charges against consumers so that the *pro rata* charge for current could be made lower.

Mr. Doherty then remarked that the question of forcing distributing lines under ground is being agitated all over the country. and that they were largely responsible for the dislike the public has for pole lines. It is possible to have overhead work which is neat and unobtrusive, and yet almost every central station in the country has unsightly, unpainted poles, with an irregular network of badly strung conductors, representing three or four times the number of wires needed for conduction of current. In the event of a feeder wire becoming too small, it has become the custom to string other feeders in parallel. He urged the use only of long, straight cedar poles, painted a color to harmonize with their surroundings, but said they must pay more attention to underground work. With the consent of the executive committee, he would offer a gold medal suitably inscribed, for the best paper on underground construction.

LOUIS A. FERGUSON.
PRESIDENT NATIONAL ELECTRIC LIGHT ASSOCIATION.

In closing, Mr. Doherty returned to the work of the association, and suggested that it have a Wrinkle Department, an Advertising Department, a Department of Decorative Lighting, a Department of Sign Lighting and a Department of Office Methods and Accounting, with committees on Steam Results, Thefts of Current, Methods of Collection, etc. In conclusion, he remarked:

I think we should extend an invitation each year to the professors of electrical engineering in all the colleges throughout the country, and address a letter to the faculties of the universities, calling their attention to the fact that by having the professors of electrical engineering attend our conventions they can keep in closer touch with central station work, and be able to more intelligently conduct the course of studies for those students who expect to take up central station work. Each year I have occasion to employ a number of young college graduates. They come to me sadly lacking in certain respects, particularly in their lack of knowledge of the laws of heat and thermodynamics, or else they are unable to apply whatever they know regarding this subject. They also seem to be incapable of thinking of expenses as anything but operating expenses, without regard to fixed expenses, such as interest, taxes, etc., and even if they do take these fixed expenses into their calculations, they do not seem to comprehend how large an item of expense they may be if a plant can only be operated for a small portion of the time, while these expenses go on constantly, 24 hours per day and 365 days in the year. It would also be greatly desirable if they could have some knowledge of accounting, but I do not know that it is practicable to give them a proper insight into this branch of our business during their college course.

At the close of this address of President Doherty, which was listened to with much interest and applauded vigorously, the following committee was appointed, on motion of Mr. Nicholls, to consider means for carrying out Mr. Doherty's suggestions: J. H. Perkins, of Youngstown, Ohio; R. S. Kelsch, of Montreal, and C. E. Hewitt, of Elkhart, Ind. The association then went into executive session.

At the executive session on Tuesday morning, retiring Secretary Porter was given a vote of thanks, and Lieut. James Blake Cahoon was formally appoined secretary. Tuesday afternoon, when the meeting was called to order, a committee on revision of the constitution and by-laws was named, according to action taken at executive session in the morning. The committee named was: C. L. Edgar of Boston; Fred. Nicholls, of Toronto, and C. E. Hay, of Springfield, Ill. W. E. Moore, of Augusta, Ga., then read a paper on the subject: "Does it Pay to Creosote Wooden Poles for Electric Line Work?" which is printed almost in full on page 324.

A number of questions were asked Mr. Moore regarding the process which his company is using. Dr. F. A. C. Perrine spoke of the methods of treating railroad ties, as described in United States Agricultural Reports and practiced on the Southern Pacific Railroad, as being somewhat different from that described by Mr. Moore. Some of the operations that Mr. Moore had described had been found detrimental. A temperature of 300 degrees or over was too high. The rapid drawing out of sap caused explosions, which checked the wood. In answer to inquiry as to the government publications on the subject, a member said that "Metal Railroad Ties," issued by the Department of Agriculture and some other publications given in the bulletin publications of that department were worthy of recommendation. President Doherty said that a lime water bath neutralized the acid on creosote treated poles so that they could be handled with more comfort.

Best Incandescent Lamp Efficiency.

Then followed a lengthy discussion on "What Efficiency Lamp Should Be Used, and How May This Efficiency Be Determined for any Particular Station?" by H. L. Doherty, S. E. Doane, Converse D. Marsh, L. G. Van Ness and F. W. Willcox.

Messrs. Doherty, Doane and Van Ness took the ground that in most cases lamps of lower efficiency than the 3.1-watt lamp would be preferable to a higher-efficiency lamp, on account of the greater cost of lamp renewals required for the latter lamp. Messrs. Marsh and Willcox argued in favor of the 3.1-watt lamp. Mr. Willcox discussed the question very elaborately, presenting tables and charts to support his arguments in favor of the high-efficiency lamp. His argument was based on standard 16-c.p. lamps of from 100 to 125 volts, the lamps to be renewed when the candle-power has dropped to 80% of its initial value, and lamp renewals to be supplied free or at such a low price as to put the selection of the lamp to be used under the control of the company. Light was assumed to be sold exclusively by meter on a kilowatt-hour basis.

TABLE I.—USEFUL LIFE AND LAMP-RENEWAL COSTS PER KILOWATT-HOUR FOR SIXTEEN-CANDLE-POWER, 100-VOLT TO 125-VOLT LAMP AT VARIOUS INITIAL EFFICIENCIES.

Efficiency in Watts per Candle.	Total Watts.	Useful Life in hours.	Lamp-Renewal Cost per Kw.-Hour in cents. (Lamp Price, 16c.)	Lamp-Renewal Cost per Kw-Hour in cents. (Lamp Price, 20c.)
2.	32.	55	9.35	11.65
2.1	33.6	70	6.8	8.5
2.2	35.2	89	5.12	6.4
2.3	36.8	110	3.95	4.94
2.4	38.4	136	3.07	3.84
2.5	40.	166	2.41	3.01
2.6	41.6	200	1.94	2.43
2.7	43.2	236	1.56	1.96
2.8	44.8	282	1.26	1.58
2.9	46.4	336	1.02	1.28
3.0	48.	400	0.83	1.04
3.1	49.6	470	0.69	0.86
3.2	51.2	550	0.57	0.71
3.3	52.8	639	0.47	0.59
3.4	54.4	738	0.4	0.50
3.5	56.	846	0.39	0.42
3.6	57.6	965	0.29	0.36
3.7	59.2	1090	0.25	0.31
3.8	60.8	1227	0.21	0.27
3.9	62.4	1374	0.19	0.23
4.	64.	1500	0.17	0.20

Table I herewith was presented as showing the useful life and lamp renewal costs per kilowatt-hour for standard lamps, and from this table the curves in Fig. 1 were plotted.

Referring to the argument that a station can reduce its cost by the use of low-efficiency lamps, thereby enabling it to reduce rates and thus stimulate business, Mr. Willcox pointed out that low rates do not give these results unless they secure low costs to consumers, and a low-efficiency increases the consumer's bill more than it is lowered by any reduction in rates which the station can offer from the saving in lamp renewals. The use of 4-watt or low-efficiency lamps might be desired to increase income where low rates have existed, which it is not advisable or possible to increase, but to adopt low-efficiency lamps in order that low rates may be made he considered a reversal of the natural order of things. With light sold on the kilowatt-hour basis the efficiency of the lamp used makes practically no difference in the economy of operating and service except as to lamp renewals, but the minimum cost to the consumer will be secured by the use of a lamp the efficiency of which makes the sum of the cost of lamp renewals and cost of current a minimum. The efficiencies at which this minimum cost is secured are plotted in Fig. 2.

This diagram is plotted on the basis of 1000 hours' service. The cost of power is given a wide range, namely, from 1 cent to 20 cents per kilowatt-hour, and the cost of lamp renewals is placed at 16 cents for curve I and 20 cents for curve II. The vertical lines which intersect the dotted and solid curved lines indicate the initial lamp efficiency at which minimum cost for power and lamp renewals will be secured. For example, with power at 6 cents per kilowatt-hour and lamp renewals at 16 cents, the diagram shows that the best initial lamp effciency is from 2.85 to 2.9 watts per candle. From the values shown by these curves we see that no central station having suitable voltage regulation should use any lower efficiency lamp than 3.1 watts per candle. [This statement is obviously based on the very reasonable assumption that 4 cents per kilowatt-hour is the lowest rate in vogue, as the diagram clearly shows that with lower rates the best initial lamp efficiency is worse than 3.1 watts.—Ed.]

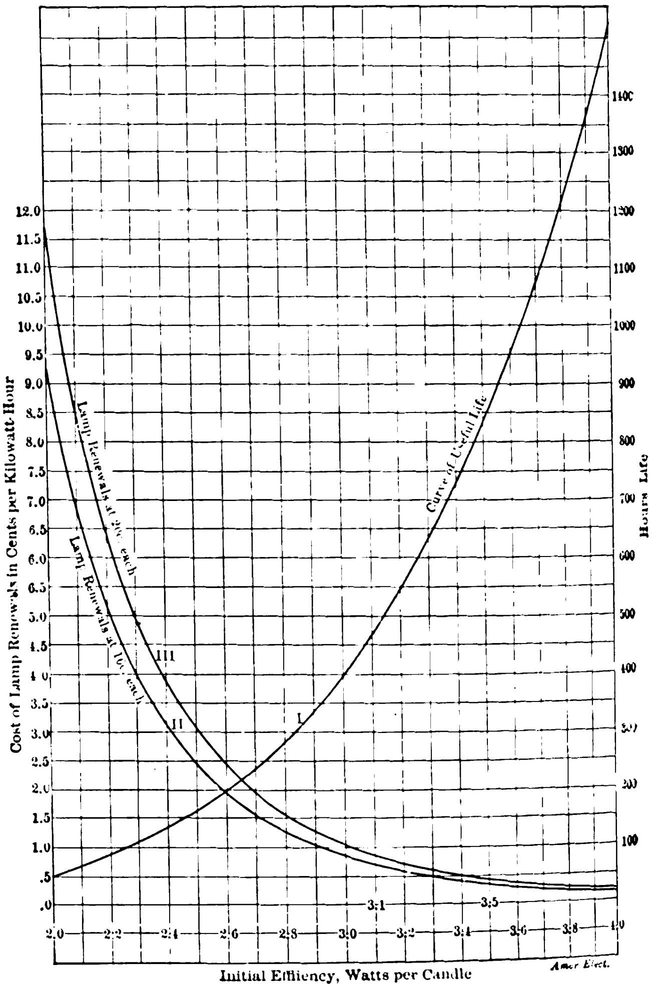

FIG. 1.—CURVES OF USEFUL LIFE AND RENEWAL COSTS.

Whether a higher efficiency lamp should be used will depend upon the average of rates given and the special conditions of supply. For consumers paying a rate of from 8 to 12 cents, the 2.75-watt lamp is a desirable one. Such a lamp, in place of the 3.1-watt lamp, has already been asked for by some central stations. It is plain, however, that the 3.1-watt lamp or better is preferable for all cases where current is sold for lighting supply, and 3.5 and 4-watt lamps are not desirable unless the station regulation is not good enough for the use of the 3.1-watt lamp. In the case of the supply of light for the station's own use, and in the case of isolated plants and all others where costs are below 3 cents per kilowatt-hour, the diagram indicates an efficiency between 3.3 and 3.5 watts per candle as the best one. With power costs below 2 cents, as in the case of electric railways, the 4-watt lamp is the one to use.

The remainder of Mr. Willcox's paper was devoted to a comparison of 16-c.p. lamps with lamps of 5, 8 and 10 candle-power. The conclusions drawn were as follows:

First—The best available efficiency in central station service for the sixteen-candle power lamp is 3.1 watts per candle. Actually, the 2.75-watt lamp is the desirable one for average rates in use.

Second—The 3.1-watt lamps can be used to advantage even when the voltage is kept 4 per cent high with fluctuations going still higher.

Fourth—The best efficiency in smaller candle-power units is that which keeps the cost per kilowatt-hour renewals about the same as the 16-candle-power costs. This basis gives a 3.6-watts per candle efficiency, or better, for eight and ten-candle power lamps.

Fifth—Very low candle-power units, being used chiefly for sign lighting, can be more liberally treated than the basis in paragraph fourth demands. An efficiency of four watts per candle is desirable for the four and five-candle-power units, reducing this to five watts per candle for the three and two-candle-power lamps, owing to the extreme fineness of filament in so small a unit.

Caring for Complaints.

In addition to the usual day sessions, night sessions were held on account of the great amount of material at hand for consideration. On Tuesday evening, a paper on "Caring for Consumers' Complaints," by Irwin Butterworth, of Denver, Col., was read by the Secretary.

Mr. Butterworth's paper described a system used by the Denver Gas & Electric Company for receiving, recording and attending to complaints and requests from customers. This system or bureau is in the personal charge of a clerk whose sole duty it is to receive complaints and requests from customers and have them promptly and satisfactorily attended to. All complaints are entered on a large book with the date and hour of receipt, and each complaint is given a reference number. An order is then filled out and turned over to the shop force for prompt attention. When the workman has attended to and remedied the complaint, and while he is still at the premises of the complainant, he fills out the remaining blank spaces on the order, stating the cause of trouble, the method of remedying it, the date and his own name, and then secures the signature of the complainant or some responsible member of his family, certifying that satisfactory attention has been given. As a check on this report, the order clerk, upon receipt of this blank sends out a return postal card to the customer, worded as follows: "On ——, 1902, you reported ——. Kindly fill out this return postal card stating whether the matter has been attended to your entire satisfaction. Your prompt reply will be greatly appreciated. Very truly yours, The Denver Gas & Electric Co."

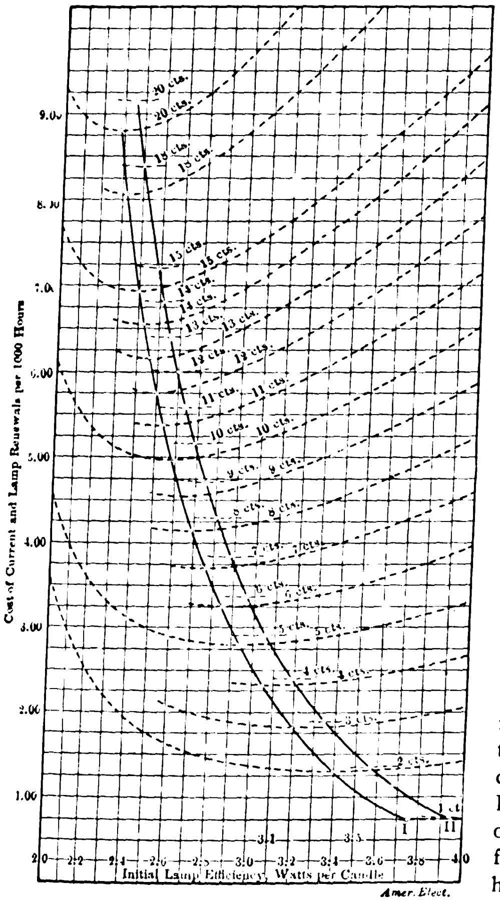

FIG. 2.—BEST EFFICIENCY CURVES.

The reference number is put on each of these cards before sending them out, in order that responses not signed may be identified, and those that are returned are checked off on the record book. Of course many of the cards are not returned, but many of them are; and most of these report the trouble to have been satisfactorily remedied, many of them expressing thanks and appreciation. Occasionally one comes back with the statement that the trouble still exists or has not been satisfactorily attended to. In such cases a second order is made out and sent to the shop for immediate attention, with proper caution to the workman taking the order. The returned postal card is then attached to the original order, and after the second order comes back with the notation that the trouble has been remedied, the workman that attended to the original one is called upon by the order clerk to explain his failure to have properly remedied the trouble. Occasionally such derelict workman is brought before the manager and properly disciplined for his remissness. In this way each man knows that his work is under the review of the management, and a high degree of efficiency on the part of the workman has thus been developed. It is, of course, the duty of the record clerk to see that a report is turned in within a reasonable time on every order that is sent out for attention.

The discussion which followed the reading of Mr. Butterworth's paper was very extended, a number of delegates describing at length courses which they pursued in dealing with dissatisfied customers. Most of the forms of complaint considered were those relating to bills. Mr. J. B. Cahoon said that in his experience, complaints of this character were easily satisfied by putting a Bristol recording wattmeter on the premises of the complainant and allowing it to remain for a month, so that the complainant could himself check up the reading of his regular meter and could also check the readings of the Bristol meter by comparison with the number of stamps in use at various times.

Accounting.

A paper on the subject of "Uniform Accounting," by Mr. J. P. Crowley, was then read, which consisted of comments on the plan of uniform accounting submitted at the last convention by Mr. Cahoon, and this was followed by a composite paper on the subject of loose-leaf ledgers by Messrs. G. E. Tripp, H. H. Fairbanks, Geo. W. Davenport, and Chas. R. Price. Mr. Tripp offered a number of objections to the loose-leaf general ledger and advocated the use of three different ledgers—a customer's ledger, general ledger and construction ledger. Mr. Fairbanks explained the card system of accounting used by his company and showed reproductions of some of the forms of cards. He stated that a card ledger can be posted quicker than a book and that the system permits a large saving of labor. Mr. Davenport did not believe in any form of accounting book and described briefly a card system used by a company having 2500 customers. Mr. Price stated that his attention had been called to the advantages of the loose-leaf ledger, but although his company has about 4500 gas and a thousand or more electric customers he has not been able to see that there would be saving enough to warrant the adoption of the loose-leaf ledger system. His company's practice is to rewrite and re-arrange the customers' lists each year. The Cambridge Gas Light Company, of Massachusetts, he stated, has adopted a card ledger system concerning which the treasurer is very enthusiastic, as the cards may be written up with an addressing machine. After some discussion of this subject, the session adjourned.

Three-Phase vs. Two-Phase Distribution.

The first paper read at the Wednesday morning session was one by Mr. B. A. Behrend, of Cincinnati, on "Three Phases *vs.* Two Phases for City Distribution," and this was immediately followed by a paper on the same subject by Mr. Chas. F. Scott, of Pittsburg, Pa. Mr. Behrend pointed out the well-known facts that although at first sight it might appear that the two circuits of a two-phase machine would not be subject to mutual induction, on account of the difference of 90 degrees in phase, one circuit does affect the potential of the other by reaction on the generator field; that a machine of given size will have the same output as a two-phaser that it would have as a three-phase generator; and the regulation of a three-phase machine with a delta-connected load is much inferior to that of a two-phase machine, equality of regulation being obtained only by the use of a fourth or neutral wire. Summing up, he said that there was comparatively little choice between the two-phase and the three-phase systems, although there are slight advantages in favor of the three-phase system.

Mr. Scott held views similar to those of Mr. Behrend and also expressed the opinion that small machines should be single-phase, medium-size machines, two-phase, and large machines three-phase, with which statement Mr. Behrend agreed in the ensuing discussion. Mr. R. S. Kelch, of Montreal, Canada, stated that in Montreal eight three-phase generators of 1000 kilowatts each were operated in multiple on a three-wire, three-phase system supplying both three-phase motors and lights, and the company found no more difficulty in balancing the load than is encountered in the three-wire Edison system. Where the individual installations are large, such as 2000 lamps or more, the practice is to transform from three phases to two. Mr. Paul Lincoln, formerly of the Niagara power plant, pointed out that it is necessary to balance a two-phase system carefully as well as a three-phase system when induction motors are used, for the reason that the motors tend naturally to rectify any unbalancing of the system by taking power from the lightly-loaded side and transferring it to the heavily-loaded side, and this entails overheating.

The report of the committee on "Standard Rules for Electrical Construction and Operation" was then presented.

Upon the opening of the afternoon session, Prof. C. P. Matthews, of Purdue University, read the third progress report of the committee for investigating the photometric values of arc lamps. The report dealt with tests of 6.6-ampere direct and alternating-current enclosed arc lamps, 7.5 ampere alternating-current lamps, and 450-watt open arc lamps under various conditions. Following the reading of the report a composite paper on "The Protection of Long-Distance Transmission Lines," by Chas. H. Baker, L. Denis, P. N. Nunn, Henry J. Gille, and Paul M. Lincoln was read. The paper was of much interest to operators of high-tension plants and does not admit of being abstracted. At the close of the session the delegates visited the works of the Bullock Electric Manufacturing Company.

At the executive session which preceded the public evening session, the officers for the ensuing year were elected as follows: President, Louis A. Ferguson, of Chicago; first vice-president, C. L. Edgar, of Boston; second vice-president, E. H. Davis, of Williamsport, Pa.; executive committee members to serve three years, S. T. Dunham, of Hartford, Conn.; P. G. Gossler, of Montreal, Can.; H. D. Hartman, of Philadelphia, Pa.; executive committee members to serve two years, J. H. Perkins, of Youngstown, Ohio; C. F. Hewitt, of Elkhart, Ind.; executive committee members to serve one year, Arthur Williams, of New York; secretary and treasurer, Lieut. Jas. Blake Cahoon, of New York; assistant secretary and treasurer, Miss Harriett Billings, of New York.

A new scale of membership fees was also adopted, to take effect Jan. 1, 1903, as follows: Initiation fees for all companies, $25; annual dues for companies in towns of 20,000 or less population, $10 a year; for companies in towns of 20,000 to 300.000 population, $25 a year; for companies in towns of over 300,000 population, $50 a year.

At the opening of the public session President-elect Ferguson was escorted to the chair at the request of President Doherty, and presided over the session. The first paper read was one by Mr. Russell Spaulding on "Display Lighting, Signs and Decoration," which was followed by one on "Possibilities of Sign and Decorative Lighting," by E. J. McAllister. These papers were chiefly descriptive in character and cannot be abstracted to advantage.

220-Volt Incandescent Lamps.

At the opening of the Thursday morning session Mr. Fred W. C. Bailey read a paper on the "Performance of Present 220-Volt Lamps," in which he gave the results of a series of tests made with high-voltage lamps. Fifty lamps of each make were tested. The results of these tests were plotted in diagrams, which were shown in connection with the paper. There were 14 lots of lamps, one of which did not contain a single lamp which came within 1½ candles of the manufacturer's rating; only five of the lots showed a percentage greater than 50 per cent which fulfilled this requirement, and three showed a percentage of 80. With respect to economy there were two lots in which none of the lamps came within ¼ of a watt per candle of the manufacturers' rating; one-half of the lamps of four lots came within this margin, and 80 per cent of three lots came within it. The initial watts per horizontal candle-power varied from 3.36 to 5.3; the average watts per candle power during the useful life varied from 3.73 to 5.88, and the estimated period of useful life varied from 467 to 3502 hours. These results are given in detail in Tables II and III.

TABLE II.—COMPARISON OF RATING AND PERFORMANCE.

LOT.	Rated Initial C.p.	Average Actual Initial C.p.	Rated Watts per C.p.	Actual Average Watts per C.p.
A	16	14.44	3.75	[illegible]
B	16	15.97	4.	4.038
C	16	16.37	3.8	3.83
D	16	16.08	4.	4.02
E	16	14.7	3.75	3.70
F	16	10.6	4.	5.63
G	16	17.08	4.	3.95
H	16	14.6	4.2	4.64
I	16	14.7	4.	4.09
J	16	15.94	3.75	4.67
K	16	15.48	4.	4.08
L	16	14.36	3.75	4.16
M	16	15.5	4.	4.22
N	16	15.95	3.4	3.29

Rates.

After some discussion of Mr. Bailey's paper the question of rates was taken up in papers by Messrs. H.L.Doherty, L. R. Wallace, Ralph J. Patterson, Samuel Scoville, E. F. Phillips, Alex. Dow and Louis A. Ferguson. Mr. Doherty said that much success had been met with in introducing at Denver and elsewhere the system of rates which he outlined in a paper read before the Association at its convention held in May, 1900. According to this system, as applied at Denver, every consumer pays $12, plus $6 for each meter more than one, plus $1.80 per lamp connected, plus 5 per cent per kw.-hour for current. From the aggregate a discount of 50 and 10 per cent is allowed. This system of rates has been adopted at Denever, Colo.; Madison, Wis.; Lincoln, Neb., and Quebec, Canada, with excellent results. Immediately upon the adoption of the scheme in Denver the output and maximum demand began to increase. From April to January the connected load increased 8 per cent, the maximum demand 32 per cent, and the output 70 per cent, the latter increase being confined to approximately 50 per cent of customers; some of the latter increased as much as 400 per cent. The increase in consumption is attributed largely to the adoption of the lower rates and not particularly to the system of charging. It is felt, however, that if a system of charging had been adopted based largely upon consumption, the rates would have had to be very much less to have brought about the same increase in output. When customers found they could buy additional current at a much lower rate, they felt more inclined to use it liberally, and many of them are now paying a gross amount greater than they paid before this system of charging was adopted.

TABLE III.—USEFUL LIFE AND AVERAGE EFFICIENCY.

Lot.	Point at which Average c. p. of Lot Declined to 80% of Initial Hours.	Average Initial Watts per Horizontal c. p.	Estimated Period of Useful Life Based on Initial Efficiency.	Average Watts per Horizontal c. p. During Useful Life.	Estimated Period of Useful Life, Based on Average Watts per c. p. During Useful Life.	Average Watts per Horizontal c. p. During 1,500 Hours.
A	635	4.	1,041	4.40	957	4.99
B	20	3.89	915	4.5	875	5.77
C	620	3.83	830	4.23	817	4.89
D	638	4.04	1,095	4.34	905	5.10
E	234	3.39	483	3.76	486	5.06
F	1,210	5.30	3,596	5.88	3,502	6.08
G	708	4.	1,041	4.39	943	5.
H	1,100	4.45	1,618	4.89	1,557	5.09
I	567	3.98	1,012	4.10	720	5.20
J	562	3.67	719	4.10	720	4.83
K	525	4.05	1,088	4.48	1,066	5.20
L	47	4.07	1,161	4.5	875	5.85
M	620	4.06	1,123	4.73	1,342	5.23
N	467	3.36	467	3.73	467	4.38

The paper of Mr. L. R. Wallis related to the "Four-C" system of charging, which was described in the AMERICAN ELECTRICIAN of December, 1900, and also at last year's Electric Light Convention. This system has been applied in a Massachusetts city of 30,000 inhabitants since July 1, 1901. The consumers' contract with the company for a period of one year, agreeing to pay for the capacity demanded in 16-c.p. lamps or their equivalent, at certain definite tariff rates, plus a meter rate of 6 cents per kw.-hour. The legality of this method was questioned by certain consumers, and an appeal was taken to the Massachusetts State Board of Gas and Electric Light Commissioners, who, after thorough investigation, rendered an opinion favorable to the company. The board in its opinion said, that "The system is evidently intended to increase the profits of the company by increasing its output, and at the same time to reduce the price to a large majority of its customers, enabling them, without a proportionate increase in their bills, to use lights much more freely and with increased convenience."

Mr. Ralph J. Patterson described a system in operation in Waterville, Maine. The schedule rates are based upon the number of lamps contracted for, irrespective of the number actually installed, and a customer is allowed to make that number anything he chooses, except in some residences where 10 lights or less is the actual number installed, in which case the actual number installed is taken. According to the rate schedule for residences, a house using 1 lamp would pay $0.80 per month; for 5 lamps, $1.41 per month; for 10 lamps, $2.46 per month; for 15 lamps, $3.13; for 20 lamps, $3.52 per month, and for more than 20 lamps, 17½ cents per lamp per month. A device is installed which will not permit the simultaneous use of more lamps than have been contracted for.

Mr. Samuel Scovil criticised both the Wallis and Doherty methods of charging. He said that the former is sadly deficient.

since in dividing the total installation and fixed cost by the capacity demanded, or to be demanded, it fails to take into account the fact that there is a great difference in the cost of a distribution system for 500 customers and one customer, and the cost of serving 500 customers as compared with serving one customer. Mr. Doherty, with his charge "per customer," in addition to other charges, does provide for some of the difference which a company can profitably allow in serving the two classes of customers above considered. But after adopting what was figured to be an equitable system of charges, these were reduced by a discount of 50 and 10 per cent, thus reducing the guarantees which the great bulk of customers are asked to make, to such a small amount that they do not have to give them any consideration whatever. Mr. Scovil considered that all Mr. Doherty's system is doing in Denver is to allow him to carry on his competitive war on lines that tend to increase the load factor of his station, so that if there is any profit per unit in selling current at the price fixed by him, he gets all there is in the business. He considers that a correct system of charging would be one that bases the cost of service to the consumer in the main on the hour's use of the capacity demanded by him, and that the tariff schedule should be proportionate to the cost. These costs consist of those expenses which are fixed and those which are proportional to the kw-hour output. There is, however, a diversity of opinion as to what expenses are fixed and what are proportional to the output, and until an agreement could be arrived at on these points, Mr. Scovil considers that no universal system of tariff is possible.

Mr. E. F. Phillips said that his station has made a radical departure in the matter of rates and adopted a system whereby the consumer was required to pay at the rate of 16 cents per kilowatt-hour for the first two hours per day of connected load, or 60 hours monthly; all current used in excess of this to be paid for at 5 cents per kilowatt-hour, the total bill to be subject to discount if paid within 10 days of date of bill. This departure had the effect of widening out the curve of the peak load and brought quite a noticeable amount of new business. The net earnings per kilowatt-hour of output fell off somewhat, yet the net earnings to the company for the year showed a healthy increase. During this time the regular rate for power service had been put at 10 cents per kilowatt-hour; this was changed to 10 cents per kilowatt-hour for the first 30 hours per month per kilowatt connected, and excess current charged for at 5 cents per kilowatt-hour. Within a year the power rate was changed to 10 cents per kilowatt-hour for the first 30 hours of "maximum demand" instead of "connected load." This brought about a very noticeable increase in power service and a corresponding change in the light load curve. In the meantime the two-hour per day rate had been applied to the residence service, and produced general satisfaction; the method pursued was an arbitrary one based on the average use, thus to form the maximum demand for the 16 cents rate, with excess current at 5 cents and minimum bill of $1 per month. The average earnings per kilowatt of output showed in the residence district a decided drop, yet the net earnings were increased. This rate is one still in use for residences. The next step was the adoption of a 1-year contract system on the maximum demand plan and a change to one hour per day at the 16 cent per kilowatt-hour price, excess current at 5 cents per kilowatt-hour—the maximum demand contract, however, to cover all electrical service used by the customer. This has proved the most popular of any plan yet instituted and is the one in general use by the company at the present time for all service except residences; but it is optional with the customer as to whether he shall take the open order at 60 hours per month of connected load, or 30 hours per month on maximum demand. In the case of arc lamp service, however, the customer is required to take the maximum-payment contract for one year. This maximum demand arrangement necessitated the installation of the Wright demand meter in all cases where connected load was known to be in excess of the demand.

Mr. Alexander Dow stated that after five years' experience with differential rates, he is of the opinion that when a reduction of rate is to be made it should be done in such a manner that the reduction will apply on the business which is being done at a profit, and not on the business which is being done without profit, or at a loss. The theory of equity requires that each kilowatt-hour sold should bring a uniform profit to to the company. If any current is sold at a loss, a higher margin of profit is necessary with respect to the business that is done at a profit. Mr. Dow said that he nevertheless recognizes that the ideal service is that which operates with a constant load 24 hours a day, and that the ideal rate is that which is uniform to all users, regardless of the time of day or season of the year. Therefore advantage should be taken of every class of business which will straighten the load curve. This may be done in some cases by obtaining a day load which can be switched off at dusk; in other cases, as in New York, by linking together districts whose periods of maximum load succeed one another; or possibly in future by using such a large proportion of storage batteries that inequalities are thereby done away with. While at present the load curve cannot be so straightened as to warrant a uniform rate, efforts should be made in that direction; and while recognizing the necessity and the equity of the differential rate under present conditions, we should persistently endeavor to so modify these conditions that the necessity for the differential rate will ultimately disappear.

Mr. Louis A. Ferguson considered that the necessity for the adoption of an equitable rate of charging is becoming more and more apparent, because on all sides city authorities are bringing forward the cry of discrimination, and sooner or later those companies that are not prepared to go before their city council or their state legislature and demonstrate conclusively that the system on which they charge for supply of electricity is equitable, will be subjected to unfair uniform kilowatt-regulations. Mr. Ferguson believes that an equitable system of charging, which is based on underlying principles of cost of production, will not only withstand the attacks of the city and state authorities, but will return to the stockholders a fair dividend on their investment.

Mr. Ferguson gave an account of the different methods of charging that had been pursued by the Chicago Edison Company, none of which were satisfactory until the adoption, in 1897, of the Wright demand system in modified form. Each monthly bill is based upon the customer's actual maximum in that month, and during each of the six winter months the customer is charged the full rate of 20 cents per kilowatt-hour for all electricity consumed monthly until the consumption reaches the equivalent of 45 hours' use, or the maximum number of lamps lighted simultaneously, as indicated by the Wright demand meter; 10 cents per kilowatt-hour being charged for all electricity consumed in excess of that amount. During the summer months the full rate is charged for light consumption until it reaches the equivalent of 15 hours' use of the maximum number of lamps lighted simultaneously, and for all electricity in excess of that amount the rate of charge is 10 cents per kilowatt-hour. For the low-rate portion of the bill, a discount is given, the amount ranging from 5 per cent to customers whose low-rate portion was 100, and increasing by 5 per cent for each 100 of the low-rate portion, making the maximum discount 50 per cent in the case of a customer whose low-rate portion is 1000. Within the last year this method has been simplified by abandoning the difference between summer and winter rates.

In charging for power, the full rate is 10 cents per kilowatt-hour for the first 30 hours' use of the maximum power per month. The low rate is 8 cents per kilowatt-hour for the second 30 hours' use, 6 cents for the third 30 hours' use, 4 cents for the next 450 hours' use, and 3 cents for the next 180 hours' use. The low-rate portion of the bill is subjected to discount ranging from 15 per cent on amounts of $20 to $40, to 40 per cent on amounts ranging from $100 to $200. These rates for power give a range from 10 cents to 2.88 cents per kilowatt-hour as a minimum.

In Chicago there are in use at present, a total of 13,022 Wright demand meters and 15,633 recording meters, the income from the customers using Wright demand meters being $986,560 for the fiscal year ending March 1. The average discount from the list is 31.1 per cent for light and 49.1 per cent for power. Of the Wright demand meters 94 per cent are for 10 and 25 amperes, showing that the bulk of the business on this system is with relatively small customers. The total number of customers on the book is 18,623, of which 61.7 per cent are on the Wright demand system. Of 2737 power customers, 50.7 per cent are served on the Wright demand system. The total investment in meters of all kinds is $353,000, of which 23 per cent is for Wright demand meters. The load factor of the Chicago companies for the last fiscal year was 27.1 per cent, showing an average daily use of the system's maximum for 6½ hours. Before adopting the Wright demand system of charging, the total yearly expense per recording meter, including salaries, supplies, repairs and renewals, was $2.95. Last year the total yearly maintenance expense per recording meter, including the same items, was only $1.85, showing that the cost of maintaining Wright demand meters is inconsequential.

Criticism has been sometimes made of the method used in Chicago on the ground that the company might do a large amount of unprofitable business, owing to the fact that there is no guarantee to the company that the consumer will pay for at least one hour's daily use of the maximum demand. An analysis shows that of the total income from Wright demand business, only 8.6 per cent of the total comes from customers using the equivalent of the maximum demand for less than one hour daily; and, furthermore, that the ratio of gross delivery to full rate lamp hours of these "shortage customers," is 57.3 per cent. Thus the actual amount of business which falls short of using the maximum demand one hour per day is only 3.67 per cent. After five years' experience with this system, Mr. Ferguson said that he is strongly convinced of the necessity of some such equitable tariff being adopted by all electric light companies in every city and town, not only in justice to the consumer, but to protect the investor from loss of revenue resulting from injudicious contracting and unfair municipal price regulation, both of which will become inevitable without a proper system of charging.

Steam Turbines.

At the Thursday afternoon session Mr. Francis Hodgkinson read a paper on "Steam Turbines," in which he pointed out that the conditions of operation most desirable for turbine work are a fairly high boiler pressure, a good vacuum, and superheated steam. A good vacuum is advantageous because the turbine is capable of utilizing the expansive energy of the steam down to the utmost limits of exhaust pressure. The use of superheated steam is facilitated by reason of the fact that there are no rubbing surfaces inside the turbine where the parts are in contact with the steam, so that there are none of the objectionable features that are sometimes incidental to the operation of reciprocating engines with superheated steam. Experiments seem to show that for every five degrees of superheat there is at least 1 per cent gain in economy. With reference to the space occupied by turbines, he gave the following dimensions: 400-kw. turbine-generator outfit, 19 ft. x 4 ft. 6 ins. floor space and 7 ft. 6 ins. high; 750-kw. outfit running at 1500 r.p.m. and having two cylinders with a reheating receiver between, 36 ft. x 8 ft. floor space, and 7 ft. 6 ins. high; 1000-kw. outfit of the same type, 42 ft. x 8 ft. floor space and 8 ft. high. The steam velocities used in the Westinghouse turbine are about 600 ft. per second, and it has been found that with this velocity the turbine blades do not wear appreciably. In the ensuing discussion Mr. Hodgkinson said that a vacuum of 28 ins. is considered good practice for turbine work, and that the vacuum should not be less than 27 ins.

After some routine business the committee which was appointed to consider and report upon suggestions contained in the opening address of the president submitted its report, in which it was recommended that a "progress editor" be elected, whose duty it would be to report at each meeting on the progress of the art by subjects for the year just past; and as the report of the nominating committee had already been made, the special committee recommended that the position of progress editor for the coming year be filled by the incoming president. The committee also recommended in accordance with Mr. Doherty's suggestion, the institution of a "Wrinkle Department," the editor to be appointed by the incoming president and to appoint in turn his assistants. It was further recommended that the incoming president appoint reporters on Decorative Lighting, Sign Lighting, Office Methods and Accounting, and a committee of one on Lost and Unaccounted-for Current. The report of the committee was adopted by the convention, and on motion of Mr. J. F. Dusman resolutions were passed accepting the third progress report of the committee for investigating the photometric value of arc lamps, extending a vote of thanks to Prof. Matthews for excellent work on the committee and requesting him to continue his investigations through the coming year.

Hot Water vs. Steam Heating.

A composite paper on the subject of "Hot Water vs. Steam Heating," by Messrs. J. F. Porter, P. H. Korst and C. R. Mauensell, was then read. Mr. Porter stated that his company first constructed about 3000 feet of mains from which business houses were supplied, but the satisfaction given by the service was such that during the following year the lines were extended to the resident district, which is situated on a hill above the business portion of the town. The expansion tank is located on a high point above all radiators and 140 ft. above the level of the pumps. The company supplies about 50,000 ft. of radiation in residences, business houses, offices and schools, and where the amount of radiation installed is sufficient to counteract the exposure, the system is giving excellent satisfaction. No live steam has been used, and the repairs for two years have amounted to less than $400.

During the first two years the plant was operated without any back pressure on the engines, but owing to the increase in the number of feet of radiation, and the severity of the past winter, it was found necessary to weight the back-pressure valve until the gauge showed three to five pounds during the period when there was but little electric light and power load; during the late afternoon and until midnight there was ample steam to furnish heat without back pressure on the engines. The company installed a hot-water system, instead of an exhaust-steam system because of the fact that no back pressure was required, and returning the water to the power plant. All the heat units not actually thrown off for the purpose of earning revenue were retained. It has been found that water sent out at 200° will give, at a distance of 2000 feet from the power house, a temperature of 198° where the water leaves the main line to enter the service of the customer; also, that when the water is sent out at 200° and passes through the radiators and returns to the power house, the loss varies from 30° to 50°, depending upon the outside temperature.

Very little trouble has been experienced from leakage on the pipe system, the only loss to the mains and service pipes being caused by surface water passing through the sandy covering and corroding the pipe on its exterior. The company has had some difficulty by allowing parties to install less radiation than our figures would indicate, or because of the fact that the piping was imperfectly proportioned.

Mr. P. H. Korst's company was influenced in the selection of its heating system by the features in favor of hot water of utilizing exhaust steam without putting back pressure on the engines, being able even to run the engines condensing and passing the exhaust steam through a circulating water heater on its way to the condenser, and being able to graduate the heat economically. With exhaust steam heat a temperature of 212° or more is obtained whenever there is steam on, and for fully three-fourths of the heating season this is more than is needed. Again, much heat and pure water are lost when condensation is wasted in the sewers. With hot water the temperature of the water can be varied to suit the outside temperature, and the condensed exhaust steam in the heater can be returned to the boilers for trapping out the oil if the engines are run non-condensing. The absence of noise, water hammer and odor are also good features of the hot-water system, and are talking points with prospective users. The large amount of water in the pipes and radiators gives a certain amount of storage capacity for heat, and the system may be stopped in emergencies with a very gradual cooling of the water. Fuel economizers can be used to impart steam heat to the water and live steam heaters are generally used to add extra heat in very severe weather, and also at times when sufficient exhaust steam cannot be obtained.

In a hot-water system with a forced circulation, no attention need be given to the grade of the flow or return pipes, which simplifies and cheapens the installation. If a closed system is used, that is, one not open to the atmosphere at any point, the circulating pumps take only enough power to overcome the difference in pressure between the water in the flow and return pipes, or just enough to overcome the friction of the water in the pipes. In an open system, in addition to this, enough pressure must be used to raise the water to the highest point on the system.

Proper insulation of mains and service pipes is a simpler proposition with hot water than with steam, on account of the lower temperature, which permits the use of efficient material that would deteriorate under the higher temperature of steam heating.

There is some question about the method of charging. Some sell heat as they would light, by meter, having a fixed charge per square foot of radiating service installed for the season. The customer can regulate the expense by the amount of radiation installed. If he has not enough radiation, he necessarily does not keep his place up to a comfortable temperature; like a dimly-lighted store on account of too few lights. These people are always a thorn in the flesh of the central station man, for not only do they frequently telephone to see if we will not raise the temperature of the water, but they do not give the real reason to people asking why the store is cold, and thereby discredit is thrown on the system.

The other method is to charge according to the cubic contents of the space to be heated, with addition for variations in exposure of walls, etc., and then install enough radiation to keep the rooms comfortable at all times. This is the more satisfactory system, but usually makes the cost of heating exceed considerably that obtained with stoves or furnaces, since a prospective customer will not always admit the greater worth of a heat that is uniform throughout the building and always in just the right quantity.

TABLE IV.—PRESSURE CARRIED ON EXHAUST HEATING SYSTEM AND NUMBER OF HOURS CARRIED FOR SEASON OF 1901 AND 1902.

Pounds Pressure.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Total Hours.
No Steam	148	4	...	...	...	12	164
Exhaust	432	168	16	40	12	204	872
Exhaust to 2 pounds	40	136	64	68	32	116	456
Exhaust to 3 pounds	...	52	120	80	64	44	360
1 pound	4	56	64	60	24	44	252
2 pounds	116	152	112	120	112	176	788
3 pounds	4	144	172	120	84	112	638
4 pounds	...	8	56	136	136	24	360
5 pounds	...	...	48	36	76	...	160
5½ pounds	...	...	76	60	112	12	260
6 pounds	...	...	16	24	20	...	60
Total hrs. Exhaust	432	168	16	40	12	204	...
Total hrs. No Steam	148	4	...	...	...	204	...
Total hrs. Pressure	164	548	728	704	660	528	...
Average pressure	2lbs.	2.2	3.1	3.17	3.66	2.4	...

Mr. C. R. Maunsell said that the heating plant of his company (at Topeka, Kansas) has proven a particularly good investment. The plant has been in operation for five years and now contains 5935 feet of street mains, 30 meters, and the usual service connections. The cost of operation, taking into account everything except extra wear and tear on the boilers, has been 37 per cent of the gross revenue. The increased depreciation of the boilers should be properly considered, but would only be an estimate at best. No increased labor has been necessary; coal-handling machinery and mechanical stokers are used. The effect of back pressure while operating is not such a serious matter as many have been led to believe.

Tables IV and VI herewith give the salient data applying to this plant, and are self-explanatory.

The engineers regulate the steam pressure of the heating plant by a schedule based on the average temperatures for the Topeka locality during the past twenty years, given by the U. S. Weather Bureau from October to May inclusive. These averages are: October, 56°; November, 41.2°; December, 34.8°; January, 26.8°; February, 31.2°; March, 41°; April, 56.8° and May, 63.4°. The operating schedule is as follows:

The system comprises 12,763 square feet of radiation in mains, 1640 square feet of radiation in service pipes, 8640 square feet of radiation in covered piping in buildings not charged for, and 67,239 square feet of radiation charged for. This radiating surface heats 6,528,475 cubic feet of space.

TABLE V.—AVERAGE TEMPERATURES FOR FIVE YEARS AT TOPEKA.

	1897 and 1898	1898 and 1899	1899 and 1900	1900 and 1901	1901 and 1902
October	63.1	53.6	63.0	62.8	60.8
November	43.9	39.4	49.8	41.6	44.2
December	28.2	27.5	30.3	35.7	28.7
January	31.7	30.5	34.1	33.3	30.4
February	35.9	18.9	24.8	26.3	22.2
March	43.8	34.6	41.0	42.2	45.2
April	53.0	53.6	57.4	53.4	...
May	63.3	67.8	66.3	63.4	...
Average for Season	45.37	40.7	45.95	44.84	...

The amount of steam condensed per square foot of radiation during the heating season, as measured by the water meter, is 360 pounds; this equals at meter rate of 60 cents per 1000 pounds of water, about 22 cents per square foot of radiation. The greatest distance from the power house to which heating service is supplied is 2800 ft.

TABLE VI.—SCHEDULE OF STEAM PRESSURES FOR RUNNING ENGINEER TO MAINTAIN ON EXHAUST-STEAM-HEATING SYSTEM, IN ACCORDANCE WITH OUTSIDE TEMPERATURES.—ABOVE 70° NO STEAM.

Temperature Degrees	5:30 A. M. to 6 P. M.	6 P. M. to 11:30 P. M	11:30 P. M to 5:30 A. M.
68 to 55	Exhaust only	...	...
54 to 40	2 pounds	Exhaust to 2 pounds	Exhaust only
39 to 28	3 pounds	Exhaust to 3 pounds	1 pound
27 to 19	4 pounds	4 pounds	2 pounds
18 to 9	5½ pounds	5 pounds	2 pounds
8 to 0	5½ pounds	5 pounds	2 pounds
1 to 10 below	6 pounds	6 pounds	3 pounds

NOTE.—"Exhaust only," means no pressure whatever. "Exhaust to any pressure," means no live steam to keep pressure. Where pounds of pressure are given, if the exhaust is not sufficient, supply with live steam.

In order to operate at minimum pressure the company uses a set of specifications for steam-fitters which must be observed in putting in consumers' radiators. One of the features specified is that a cast-iron continuous coil with a heating surface equal to one-fifth of the total heating surface of the radiators in the building must be in the discharge line of the steam trap, and provision made for passing cold air over the coil and thence to a register placed at some point where heat will always be needed when steam is in the system. The box containing this coil must be lined with tin and the coil so placed that the air will pass over each section and not along the sides of the box. This arrangement is necessary in order to extract the remaining heat from the water before discharging it to the sewer and thus prevent the waste of heat that would otherwise occur. In the measurement of heating surface Table VII is used.

TABLE VII.—CONSTANTS FOR ASCERTAINING THE HEATING SURFACE IN PIPING.

½ inch, 22;	¾ inch, 275;	1 inch, .344;	1¼ inch, .434;
1½ inch, .497;	2 inch, .621;	2½ inch, .753;	3 inch, .916;
3½ inch, 1.047;	4 inch, 1.178;	4½ inch, 1.309;	5 inch, 1.456;
6 inch, 1.734;			

Multiply the total length of pipe by the decimal for each size of pipe.

Steam is supplied by a flat rate on bill contract or by meter on the following conditions: If the building to be heated contains a store room on the first floor and offices or living rooms on the upper floors, the company will contract with the tenant of the store direct, but will not furnish steam to the tenants of the upper floors unless the owner of the building will sign a contract for the service. Where the building is large and occupied by transient tenants, as in the case of offices, hotels, or living apartments, the meter system is recommended. No building in which a service pipe and trap are required will be supplied with steam unless a minimum agreement for 100 feet of heating surface is made.

If steam is wasted by consumers not turning off radiators in moderate weather, the company reserves the right to charge by meter. Buildings to be heated from the street mains must have sufficient radiating surface so that they can be heated to a temperature of 72° in zero weather with a steam pressure of 2 pounds, and in no case will an installation for heating be accepted unless there is one square foot of heating surface for each 100 cubic feet of air space.

Liquid Boiler Fuel.

Two papers were read on the subject of "Liquid Fuel—Boiler Firing with Oil," one by Mr. Jas. W. Warren, and the other by Mr. H. T. Edgar. Mr. Warren gave an account of his experience with the California petroleums, which are of asphaltum base, and carry with them about 30 per cent of asphalt. At the station of the Los Angeles Electric Company the fuel is pumped from a main storage tank to the furnace supply tank of 100 barrels capacity, where it is heated to 80° F. It is then pumped at 20 lbs. pressure through pipes within the breeching of the boilers, where it is heated to 190° F., and then passed to the burners. The burners are of the spray type, using steam as a medium for spraying the oil. Each burner has an evaporation efficiency of 3000 barrels of water per hour from and at 190° F.

A high temperature thermometer in the smoke flue or stack is necessary in order that the amount of air necessary for perfect combustion may be intelligently graduated. By the use of the thermometer the fireman can so regulate the burners that each boiler will do its proportional amount of work, the temperature of the stack gases being kept at 450°. The evaporative efficiency of California oil as compared with the same weight of average good steam coal is 20 per cent higher. There is a saving of 75 per cent in the cost of keeping the boiler in clean condition, and the use of liquid fuel solves the smoke problem, and also reduces the deterioration of the steam generating apparatus 75 per cent, and of the repair account 80 per cent. In conclusion, Mr. Warren says that the record of results obtained from the use of liquid fuel in Southern California stands out so prominently in favor of that fuel that many of the large steam generating plants in the northern part of the State have abandoned the use of coal in favor of liquid fuel.

Mr. H. T. Edgar gaves the result of his experience in burning Texas fuel oil at the electric light plant at El Paso, Tex. The oil is stored in steel tanks buried in the ground, and is drawn from the tanks through a 1½-in. iron pipe, which discharges through a 1-in. pipe into a small chamber about 14 ins. in diameter by 2 ft. 6 ins. long, placed by the pumps. The oil enters this chamber at one end, passing through a partition of very fine wire gauze, and at the other end comes in contact with a coil heated with the exhaust steam from the pump, thus raising the temperature of the oil to about 145° F. The oil is sprayed from the burners by steam, and a perfectly steady pressure is requisite in order to insure continuity of operation by the burners. In order to obtain a steady pressure an auxiliary air chamber is required. It is stated that a very great saving has been made at the El Paso station through the substitution of oil for coal. It is claimed by the advocates of fuel oil that four barrels of 42 gallons are equal to one ton of good bituminous coal. Results of tests made by the waterworks company of El Paso show that the cost of burning fuel oil is but half the cost of burning coal, when the coal costs $5 per ton and the fuel oil 70 cents per barrel.

Gas Engines for Central Stations.

There was also presented a paper on the "Advantages of Gas Engines for Central Station Work," by Mr. Chas. H. Williams, in which the author gave the results of operating a gas engine station at Madison, Wis., together with data gathered from other gas engine stations. Tests made of the steam generating plant in the Madison station showed that the efficiency of energy transformation is 6.6 per cent under favorable average working conditions. It is stated that while this efficiency may appear low to a great many central station men, it probably represents much better than the average conditions; and that the large majority of the smaller stations in operation throughout the country will not transform more than from 2.5 per cent to 4 per cent of the energy of the coal into dynamic energy. In the case of the Madison gas engine plant, 20.8 per cent of the original number of heat units contained in the pound of coal that was put into the gas generator was utilized, or 3016 heat units for useful work per lb. of coal, against 1008 per lb. with steam. Mr. Williams discussed in his paper a number of points connected with the operation of gas engines, and gives data as to the thermal value of different kinds of gas.

Data are also given as to the operation of gas engine central station plants located at Mankato, Minn., and Oshkosh, Wis. At Mankato there are installed one 85-h.p. and and 125-h.p. gas engine, and recently there have been added two additional 50-h.p. engines. These furnish power for 107 32-c.p. lamps, 63 2000-c.p. open arcs, 35 commercial multiple arcs and 1800 16-c.p. incandescent lamps, together with a motor load of 60-horse-power. The books of the Mankato company show that the amount of gas used for the six months ending January, 1902, was about 78 per cent increase over the previous gas output, and that this increase lowered the cost of the gas to the company 8 cents per thousand; this was exactly the same as giving them an additional profit of 8 cents per thousand on every thousand sent out to its regular customers. Mr. Williams considers that it is perfectly legitimate for that company to credit the gas engine account with 8 cents per thousand on 16,000,000 cubit feet of gas, that being its actual output, or $1280 per annum; and this credit amounts to 18 per cent of the total amount which it had paid for power previously.

At the Oshkosh plant there were installed two 50-h.p. and two 125-h.p. gas engines, and the output is 45,000,000 cubic feet of gas per year. The extra output here lowered the cost of gas in the holder 8 cents per thousand, so that the gas engine should be credited with $3600 per year due to decreased cost in gas generation.

There are also installed two gas engines at Red Wing, Minn., two at La Crosse, Wis., and three at Appleton, Wis., all running on illuminating gas. The Bradford, Pa., central station has three 150-h.p. and one 210-h.p. gas engine, which have been in operation for three years, and that company is just installing an additional 210-h.p. engine. The manager of the plant, Mr. J. H. Rose, speaks highly of this installation. Formerly steam engines were used, the boilers being fired with gas. The last days of the steam plant showed a consumption of 51.09 cubic feet of gas per indicated horse-power, while with the gas engine the consumption is but 13.6 cubic feet per electrical horse-power, which reduced to indicated horse-power would be equivalent to between 11 and 12 cubic feet. The gas engine repairs for the year 1901 amounted to $196.90, including extra exhaust valves for all the engines.

Several gas engine plants for furnishing power to manufacturing establishments were referred to. In conclusion Mr. Williams says that so far as reliability of operation is concerned, he believes the earlier manufacturers are more to blame than anyone else for what trouble was experienced, too many units having been sold with the assurance that anyone could run them. The same advice carried out at a steam station would put it on a losing basis. There are a very few small details which demand intelligent and regular attendance of the gas engine, and if these proper conditions are maintained the engine will operate satisfactorily, and the attendance troubles are over.

Watt-Meter Improvement.

Under the title, "What Improvement is Desired in Meters," papers were presented by Messrs. Robert Ferris and Clifford A. White. Mr. Ferris offered the following suggestions: "A universal meter in size and style; a blackboard for meters, of a standard pattern, which could be adapted to meters of any make on the market; a registering dial that would read directly in dollars and cents, or if not that, then the adoption as a standard of direct reading dials and a simple tell-tale hand or clock for calibrating purposes; a meter that would take the place of the combination of watt and discount meters, having the effect of registering at different rates of speed, which would be governed by the load that was passing. To illustrate, assume a 100-volt wattmeter of 25 amperes capacity, which instead of showing a straight line from five per cent of its capacity to full load, would register accurately at full load, and as the load dropped the registration would be a certain per cent slow or fast. Of course, the reading would not give the actual watt-hours, but it would be sufficient to call the units, which would be charged for at a uniform rate.

Speaking from the standpoint of a cashier of a central station, Mr. White said that anything that concerns the public should be as simple as possible. Therefore the meter dial should read direct in kilowatt-hours, thereby eliminating any constants; the use of watt-hours should be abandoned, for by adopting the rule of reading in every case the figures the hand has passed on the unit dial, the error in reading would never amount to more than 10 cents to the customer, and the total sales of the company would never be affected at all. A direct-reading dial should be designed to replace those requiring a constant, for it is next to impossible to make the customer understand the meaning of the latter. Testing should be done at the dial and not at the disk.

Just before the close of the convention it was voted to hold next year's meeting at Chicago. The 1904 convention will be held at the St. Louis Exposition grounds by invitation of the Exposition officials.

THE 50,000-VOLT TRANSMISSION PLANT OF THE MISSOURI RIVER POWER COMPANY.

BY W. G. M'CONNON.

Although several plants have been proposed for the use of voltages higher than 40,000, the distinction of being the first to place in actual commercial service a large plant employing 50,000 volts transmission belongs to the Missouri River Power Company. This installation was completed and the apparatus placed in operation about the first of March, and it is to be noted that since the starting of the plant there has been no mishap of any kind to the line or apparatus. This, the writer believes, is somewhat exceptional in undertakings of this magnitude and character, since it is generally expected that at the start minor difficulties are liable to be met with which, though possibly not serious, will nevertheless affect the continuous service of the plant.

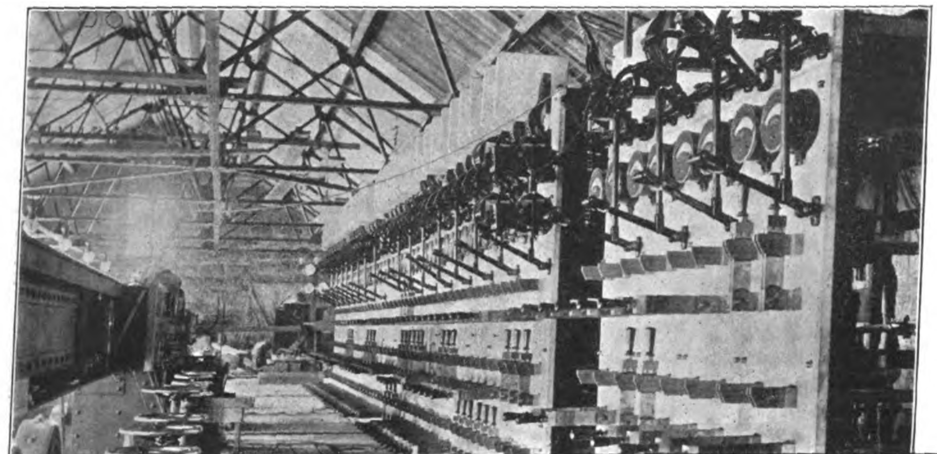

FIG. 1.—SWITCHBOARD.

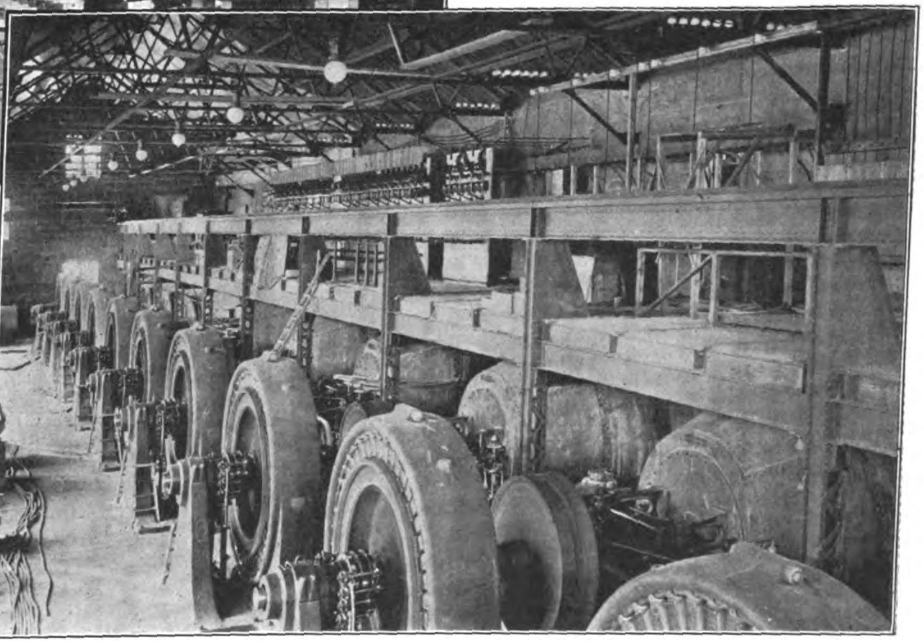

FIG. 2.—TURBINE-DRIVEN GENERATORS.

The present power-house of the Missouri River Power Company is located on the Missouri River about twenty miles from and almost directly east of Helena, Mont., at the mouth of what was formerly known as Black Rock Canyon, and in the town of Canyon Ferry. At the mouth of the canyon a dam has been thrown across the river, about 480 feet in length and designed to give a 30-ft. head of water. The location of the dam at Canyon Ferry enabled the company to take advantage of a low-lying valley just above the entrance of the canyon in which to hold at all times a large volume of water in reserve. At the upper end of the canyon the water spreads out over this valley, forming a lake about seven miles long by two to three miles wide. The canyon by which the water comes to the power house is from 400 to 700 feet wide, and less than one-half mile long. The water in it does not freeze over in winter, and although the lake above freezes over, water flows to the power-house as free from ice in winter as in summer. The amount of water in the river at this point is considered sufficient to develop 10,000 horse-power the year around.

The project for a power plant at Canyon Ferry was first started about ten years ago. About four years ago, the decision to carry out the work at Canyon Ferry took definite shape, and work was started on a plant of 4000 horse-power, which consisted of four 750-kw. 550-volt two-phase Westinghouse generators, driven by Dayton Globe Iron Works water-wheels, and two 90-kw. exciters driven by independent wheels. The current from these alternators was raised by eight oil-cooled transformers from 550 volts to 10,000 volts, and transmitted to Helena and East Helena 20 miles and 14 miles away, respectively, for lighting and power service, being reduced to 2200 volts.

Recently the plant was largely increased and the equipment overhauled. The company has installed six additional 750-kw. Westinghouse generators with the necessary transformers, exciters, etc. These generators are of the same size and voltage as the first four, but are three-phase instead of two-phase and are driven by 45-in. horizontal McCormick wheels furnished by S. Morgan Smith of York, Pa. All generators in the power-house are direct connected to the wheels, flexible couplings being used throughout. With the new generators there was also installed a 225-kw., 150-volt exciter driven by a separate wheel, and a 115-kw., 150-volt exciter driven by an induction motor. To make the plant uniform throughout, the four old generators have been overhauled and changed from two-phase to three-phase. Fig. 2 shows the arrangement of generators, the switchboard gallery being on the right, directly over the water-wheels. Each water-wheel has its own governor; all the new and one of the old wheels having Lombard governors, and the remaining old wheels Replogle governors.

The switchboard gallery extends the whole length of the building, and besides carrying the switchboard carries also twelve 550 to 10,000-volt, oil-cooled transformers for the Helena and East Helena service, as well as a plug board for connecting these circuits as needed under various conditions. The main switchboard and exciter switchboard shown in Fig. 1 are both relatively simple boards in design, but massive and substantial in construction. The main board is 47 ft. 4 in. long and consists of 17 panels of blue Vermont marble, 2 in. thick. The weight of the board complete is about 20 tons, the copper alone being one-half of this weight.

The first five panels at each end are generator panels. The next two panels are feeder panels and are intended for use with the 550 to 10,000-volt transformers. The eighth panel from the end on each side supplies a bank of transformers, 550 to 50,000 volts for lines extending to Butte. The middle panel is a junction panel, on which any set of bus-bars on the two ends of the board can be thrown together, there being three sets of bus-bars on each end of the board. The instruments mounted on the board consist of eight 750-volt, alternating-current voltmeters, one for each set of bus-bars and one at each end for the machines, independently of the busses; ten alternating-current ammeters, sixteen polyphase indicating wattmeters, and six polyphase recording wattmeters. The recording wattmeters are behind the board. The exciter board consists of four panels of blue Vermont marble, similar to the main board, one for each exciter, with two sets of bus-bars. All field rheostats are mounted under the gallery floor and are controlled by hand wheels, the shafts of which come up through pedestals in front of the boards.

The distance by pole line from Canyon Ferry to the Butte sub-station is 65 miles, the route corresponding nearly with that taken by the Great Northern Railroad between East Helena and Butte. There are two lines of poles about 50 feet apart, each carrying a line of three cables arranged in an equilateral triangle, with a spacing of 78 ins. between the centers, as shown in Fig. 3. Each line consists of three seven-strand copper cables, each cable having a cross-section of slightly over 106,000 c.m. These cables are transposed five times between Canyon Ferry and Butte. The average distance apart of the poles in each line is 110 feet. Fig. 4 shows a cross section of the insulator used on the line, together with the glass sleeve fitting over the pin below the insulator. It has been found after making exhaustive tests, that a thoroughly dry oak pin, of the length used in this installation, boiled in paraffin will readily hold up alone under 50,000 volts. Hence the object of the glass sleeve below the insulator is to keep as great a length as possible of the pin dry under all conditions of weather.

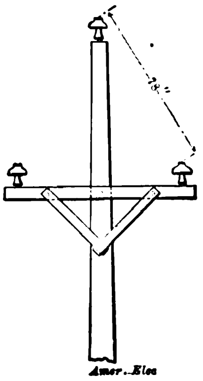

FIG. 3.

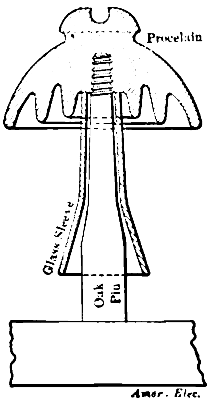

FIG. 4.

The transformers at each end of the line consist of six 950-kw. oil-insulated transformers with water-cooling coils in the cases. Those at Butte transform from 50,000 to 2200 volts. The secondary circuits at Butte consist of 600,000 c.m. bare copper cable.

The customers of the Missouri River Power Company at present are the Helena Power & Light Co., Helena & Livingston Smelting & Reduction Co., American Smelting & Refining Co., and the Big Indian Mining Co., at Helena and East Helena; and the Anaconda Copper Co., Butte & Boston Copper Co., Colorado Smelting & Mining Co., Boston & Montana Copper Mining Co., and Washoe Copper Co. at Butte.

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CREOSOTED WOODEN POLES FOR ELECTRIC LINE WORK.

BY W. E. MOORE.

Approximately one-third of the income of an electric lighting plant goes to the expense of distribution, of which the maintenance of lines constitutes quite a large item. The principal cause of the depreciation in the lines is due to the decay of poles, for as yet but few lighting companies have begun the use of iron or creosoted poles, though the iron poles are extensively used for street railway purposes.

The wooden pole is generally used on account of its low first cost and the comparative safety with which workmen may handle live wires when standing on the cross-arms, as wood is a fair insulator. Red cedar and white cedar poles have a comparatively long life, but they have now become so scarce that it is extremely difficult to secure them in sufficient numbers of suitable sizes for electric-light lines at any price in the Eastern or Southern markets, though there is yet a considerable supply of white cedar to be found in the Northwest.

Cedar, when of good quality, has the capacity of resisting the attacks of insects and fungous growths to a greater extent than any other wood used in this country for poles. This statement applies only to the heart of the stick, and more especially to red cedar; the sap or white portion quickly rots away at a point near the ground.

In the Southern and Eastern states cypress is largely used, and in its natural state has a life of from five to six years in the southern portion of the United States, and a somewhat longer life in the North. Heart-sawed pine poles have a somewhat longer life than cypress, ranging from eight to nine years; but sap pine, though readily secured in sticks of suitable size and of the necessary length, is never used, on account of its rapid decay. Its lasts scarcely more than three years when used without being treated some preservative compound. The renewal of decayed poles is much more expensive than the original cost of setting them, due to the fact that they do not all decay at one time and it is therefore necessary to set them piecemeal; and it is also necessary to take care of the wires while they are being reset, which is often quite expensive in case there are a large number of wires attached to one pole, especially junction poles. For this reason the Augusta Railway & Electric Company began some nine years ago to study the problem of treating poles by some preservative compound to increase their life.

Our first experiment consisted of charring the butts of the poles, up to a point about one foot above the earth line, and then saturating them with a coal-tar paint; but this was found to be of little service. We then tried painting the poles with various brands of preservative compounds sold under different trade names. These were also found to be of little or no benefit. In the meantime our poles, which were almost entirely of cypress, continued to rot out after an average life of about five or six years.

Some three years ago, after having investigated the results obtained both in this country and abroad from creosoting poles, we purchased and installed a creosoting plant capable of treating both poles and railway cross-ties. This plant consists of a steel cylinder 6 ft. in diameter by 102 ft. long, with heavy cast-iron heads securely supported on hinges and arranged to be clamped against a fibrous gasket on the ends of cylinder in a secure manner so as to resist a hydrostatic pressure of 150 pounds. This cylinder has a narrow-gauge railway laid through it, with tracks continuing beyond the ends of cylinder; there is sufficient ground room at one end for untreated poles, and at the other for treated poles. The cylinder has a series of 1-inch pipes laid from end to end and covering the bottom between its tracks. These pipes are arranged to be supplied with steam from an 80-hp return tubular boiler, and the steam is superheated by means of pipe coils in a separate furnace to a temperature of approximately 400° to 500° F. To the cylinder is also connected a 14-in. x 24-in. direct-acting vacuum pump, and a 14-in. x 10-in. x 18-in. direct-acting oil pressure pump.

The poles are loaded on a train of iron cars which are then drawn through the cylinder by means of a wire rope attached to a hoisting engine. The cylinder heads are bolted up tight, after which live steam is turned on the cylinder until a pressure of 80 pounds is reached, which is maintained while superheated steam is being circulated through the heating coils in the bottom of the cylinder. This steam process is continued for a period of from four to six hours, depending upon the size of timber, which has been heated up to a temperature of approximately 350° F.

The effects of evacuating, which lasts from six to four hours, is to season the green timber by drawing the sap and air from its pores. This is facilitated by the steaming to which the timber has been subjected, which has had the effect of dissolving the sap and raising it to a temperature far above the boiling point due to reduced pressure when the vacuum is applied. The sap in the pores of the wood is immediately vaporized upon the production of the vacuum, which has the effect of making the extraction of both sap and air very rapid and complete. After a treatment in the vacuum lasting from four to six hours, during which time a quantity of sap is pumped from the cylinder through the vacuum pump, the valve connecting the oil-storage-tanks which are of 30,000 gallons capacity and located in a pit below the cylinder, is opened and the atmospheric pressure forces the creosote oil up into the cylinder until it is filled.

After this the oil pressure pump is started, drawing its supply from a tank which has a gauge attached, calibrated in gallons. After the pump has completely filled the cylinder, its operation is continued until the required number of gallons of creosoting oil have been pumped into the cylinder to saturate the timber to a density of 10 to 12 pounds per cubic foot. This ordinarily requires a pressure of 60 pounds per square inch, applied for a period of time ranging from two to four hours, depending upon the diameter and kind of timber being treated.

After the required number of pounds of oil have been injected into the timber, the oil is drawn from the cylinder into the storage tanks and the steam is left circulating through the superheating coils for about one hour, for the purpose of decreasing the oil drippings from the timber.

It must be understood that steam is circulcated through superheating coils located in the bottom of the cylinder throughout the entire process, which ranges from 16 to 24 hours. The doors of the cylinder are then opened and the cars with their load of treated timber are drawn on through the cylinder to the unloading yard by means of the hoisting engine and wire cable. Another train of cars, which is standing already loaded at the other end of the cylinder, is immediately drawn in and the process repeated.

The approximate cost of the average size (say, 34-ft. length, and 8-in. top diameter) of cypress pole in the South ranges from $1.75 to $2.50 each, and the cost of creosoting approximates $20 per 1000 feet, board measure, or about twice the first cost of the pole. While we have no time test showing the ultimate life of creosoted poles in actual service, we have every reason to believe that their life will be prolonged four to six times that of untreated timber. The Bell Telephone Company has used creosoted pine poles for upwards of ten years, and where the treating has been properly done they have yet to show the first signs of decay. Sir William Preece, of the British Telegraphic Department, reported that creosoted poles had been in use in England for more than thirty years without showing indications of decay. Since the cost of treating a pole averages about twice its first cost, the economy of creosoted poles must be apparent.

Thus far we have found only one objection to creosoted poles, which is due to the tar acids contained in the creosote oil, principally carbolic acid. This acid makes the handling of the poles disagreeable, as it inflames the hands of those who handle them, and at the same time it lowers the electrical resistivity of the timber to such an extent that linemen can no longer depend upon the poles to insulate them from the ground when handling one to three thousand volt wires.

The art of treating wood for its preservation is an old one, having been practiced in one form or another for many years. Among the various chemicals used are chloride of zinc, zinc and tannin, sulphate of copper, bichloride of mercury, wood-creosote oil and dead oil of coal tar. The latter is the more generally used chemical for wood preservation, and it is also more expensive than any other. But the treatment of wood with creosote oil from coal tar has been far more successful and generally used than any other process.

The principal preservative property of creosote oil appears to be due to naphthalene, which is deposited in the pores of the wood, together with the antiseptic acids always contained in dead oil of coal tar.

[The foregoing is an abstract of a paper read at the recent National Electric Light Convention.]

The Paralleling of Alternators from the Engine Builders' Standpoint

ENGINE REQUIREMENTS FOR THE PARALLEL OPERATION OF ALTERNATORS.

BY E. M. TINGLEY.

In connection with the extensive work in electrical engineering the Westinghouse Electric & Manufacturing Company has been called upon from time to time to give information and suggestions regarding engine requirements for the parallel operation of direct-connected alternators. In response to these requests the desired information has been crystallized into the form of a specification, which is often embodied in the contract for generators or sent to engine builders for their information. The specification is as follows:

A. The engine governors should be so constructed that there is no tendency to cause a periodic transfer or surging of the load between one engine and another. This tendency may originate in the angular variation of velocity in different parts of the revolution which is common to all reciprocating engines, or to a sudden variation of load which will affect each governor in a slightly different manner, or to other causes that lead to a non-uniform speed. The engine governors should not be sensitive to such disturbances nor maintain or increase them. The effect on the engines of a periodic transfer of load occasioned by hunting between two engines running in parallel, is somewhat similar in effect to throwing the load on and off of a single engine at short equal intervals which may be measured by one or several pulsations in the combined turning efforts applied to the engine shaft. In some extreme conditions the pulsations of load may amount to more than the normal capacity of either engine. With no external load one engine may then alternately drive the other, which will evidently be a more severe condition than if the load were only applied to and removed from a single engine. If under any case of pulsating load the engines do not tend to accentuate the pulsations in turning effort and speed, then a condition favorable to parallel running is attained.

B. Variation of the rotating part of the generator through one revolution at any constant load not exceeding 25 per cent overload should not exceed one-sixteenth of the pitch angle between two consecutive poles from the position it would have if the motion were absolutely uniform at the same mean velocity. The maximum allowable variation, which is the amount the rotating part forges ahead plus the amount which it lags behind the position of uniform rotation, is, therefore, one-thirtieth of the pitch angle between two poles. Generally this is obtained by the use of a heavy flywheel. In a two-pole machine this variation is equivalent to 3° as measured on the circumference of the rotating part; in a four-pole machine it is 1½°, and in a six-pole machine 1°, or as the number of poles increase the permissible angular variation decreases.

C. The engines should have practically the same characteristics of speed regulation in order that the power delivered to their respective generators may be proportional to the load; that is, the same load on any engine should produce the same percentage drop in its speed. This is most readily obtained in engines in which at full load the speed drops from 3 to 5 per cent below the no-load speed, as a slight change in adjustment of the governors will have less relative effect than in engines in which the speed drops only 1 per cent under the same variation of load.

D. The use of governors which are adjustable while the engine is running is recommended. Slight adjustments of speed may then be made which will facilitate synchronizing the alternators or changing the load carried by the engines.

MAXIMUM PERMISSIBLE VARIATION ON EITHER SIDE OF UNIFORM ROTATION.

Poles	Angular Degrees	Per cent. of Circumference
44	1.500	0.41666
6	1.000	0.27777
8	0.750	0.20833
12	0.500	0.13888
16	0.375	0.1041
20	0.300	0.0833
24	0.250	0.0693
28	0.214	0.0594
32	0.187	0.0520
36	0.167	0.0462
40	0.150	0.0416
44	0.136	0.0378
48	0.125	0.0347
52	0.115	0.0320
56	0.107	0.0297
60	0.100	0.0278
64	0.094	0.0260
68	0.088	0.0245
72	0.083	0.0231
76	0.079	0.0219
80	0.075	0.0208

It may be noted that there is no attempt to tell how these results are to be obtained; this is a problem for the engine builder.

Some of the effects of pumping may be reviewed by considering the simplest case in which pumping occurs, namely, when two alternators are in parallel with no external load. If the alternators will work in parallel under this condition they will usually work together under load or with one or more additional units. When the two machines are connected together after being properly synchronized, nothing unusual will happen for a few seconds, but soon the ammeters will show cross-currents between the alternators as pumping commences, indicating differences of phase. The voltage of the two machines is lowered by these cross-currents and is pulsating, and, therefore, unsuitable for lighting service. The generators may also grow warm on account of the cross-currents or give out sounds indicating unusual internal mechanical forces. If the pumping increases in severity, fuses may blow, circuit-breakers open, or the generators may finally go entirely out of step.

The engines meanwhile may not show that anything unusual is happening, leading some to assume that the trouble is all in the generators. If, however, as in some cases, it is possible by looking through the arms of the flywheels to see the change in the relative angular positions of the wheels of the two engines, it will be evident that there is an actual oscillation between the two machines such as might be expected to occur if they are coupled with an elastic coupling. These disturbances are usually traceable to the engine governor, since if they were not maintained by some regularly-recurring change in steam distribution they would soon die out on account of the frictional resistance to such oscillations.

Consider, for example, a case where a load is thrown on and off a single engine and generator by a suitable switch at regular intervals. The governor may lag in its correcting effect and then overshoot the mark in maintaining an average speed. If the load is applied or removed at the instant when the governor and engine begin to recover from one of these excessive speed corrections, the effect is maintained or is made cumulative, and the engine varies periodically in speed. Now, if this intermittent load is replaced by another engine and generator there may be a resonant action between the governors on the one hand and the synchronizing force between the generators and inertia of the rotating parts on the other, which will produce the same action on the governors as did the intermittent load. The oscillations may be started either by the angular variation in speed which occurs in all reciprocating engines, or by changes of load.

In order to assist engines in parallel running it is now usual to apply dampers to the poles of the generators and synchronous machines in circuit with them, but dampers do not insure parallel operation nor are they always necessary. When the best form of damper is ineffective in reducing pumping to an allowable amount, it means that the impulses from the engines are greater than can be corrected for in the generators.

Paragraph *B* of the foregoing specifications limits the angular variation from uniform velocity solely in order to limit the value of the cross-currents between generators to what is considered a reasonable amount. The angular variation is usually calculated from the variations in crank effort and the flywheel capacities of rotating parts, since its correct measurement is exceedingly difficult.

Engines running with cranks in step will give better performance as regards themselves than with the cranks out of step, especially if the angular variation is large, since the angular difference between the two generators may be at all times smaller than the divergence from absolutely uniform rotation. With the engine cranks out of step there may be larger cross-currents between the generators, but the fluctuation in the outside circuit will frequently be smaller than with the cranks in step, since it will be due to the resultant action of two or more engines.

The stipulations of paragraph *C* in the specifications are intended simply to insure a proper division of load between two or more engines. Adjustable governors are recommended in paragraph *D* for the purpose of transferring the load from one generator to another in order to facilitate switchboard operation. Moreover, the engine governors will sometimes vary in their own adjustment, making it necessary to make corrections from time to time in order to obtain a proper division of the load. Adjustable governors also enable an unloaded engine to be synchronized with one running load.

[The above is an abstract of a paper read at the convention of the Engine Builders' Association recently held in Pittsburg.]

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THE REQUIREMENTS FOR THE PARALLELING OF ALTERNATORS AS VIEWED BY THE ENGINE BUILDER.

BY HENRY E. LONGWELL.

In a great many instances the difficulties experienced in paralleling alternators have been more or less completely overcome by tinkering with the governing mechanism on the engine, and consequently it has become fashionable to say that the troubles originate in hunting, oscillating, or otherwise faulty governors. This, however, is an unfair statement. The interaction between the generators is not necessarily caused by the hunting or oscillating of the governors, even though both phenomena are co-existent, and even though the latter tends to aggravate the former.

A more fair statement of the case is that the parallel operation of alternators imposes a duty on the governing mechanism of the engine which is abnormal and which is directly opposed to its natural function. The natural function of a governor is to regulate the supply of steam in proportion to the load. If we have two engines driving alternators in parallel, and, by reason of small speed variations, which we might as well frankly admit are unavoidable, one generator advances ever so little ahead of the other, it takes more load. To restore equilibrium we ought to be able to reduce the steam supply to the engine that is leading and to increase the supply to the engine that is lagging behind.

Now, the natural tendency of the governor is just the opposite; *i. e.*, to increase the steam supply to the heavily loaded engine and make it capable of taking more load, and to decrease the steam supply to the underloaded engine and make it less capable of taking its share of load. Furthermore, the nearer perfect the governor is as regards the performance of its natural duty, the more promptly and vigorously it does the right things at the wrong time.

Obviously a governor, unless endowed with intelligence, cannot assist parallel operation, and the best we can hope to do is to hobble it in such a way as to make it offer as little opposition as possible. In other words, we must sacrifice as far as is safe, all the qualities that have hitherto been regarded as synonymous with excellence, and make the governor so that it will not act quickly under any circumstances, and will not respond at all to moderate changes in load or speed. Hence the use of dash pots, friction brakes, etc.; not because the governor is faulty, but because it must be made so as to prevent its resisting the contradictory demands of the electrical part of the plant. No properly designed governor on an engine in any service other than that of running alternators in parallel requires any of these retarding devices, and their presence ordinarily would be an open confession of faulty design.

As regards the required degree of uniformity of angular speed, one leading manufacturer of electrical machinery puts the limit of variation in one revolution at any constant load not exceeding 25 per cent overload at one-sixteenth of the pitch angle between two consecutive poles and another makes the limit 1-72 of the pitch angle. In certain instances the angular variation has been kept within the specified limit, and even with a governor made as sluggish as is safe the paralleling has been unsatisfactory, showing that the specified departure from uniform rotation does not always insure success.

It is frequently stated that the cross-currents between two alternators in parallel represent synchronizing force or the tendency of the generators to pull each other into step, and that this synchronizing force is what makes paralleling possible—that the more there is of it the better.

This looks so plausible that we have for years accepted it against the evidence of our senses, when in fact there is only one small grain of truth in it, namely, that *some* synchronizing force is necessary to make synchronizing at all possible. Synchronizing force cannot pull two generators into phase and hold them there any more than the force of gravity can pull an ordinary pendulum to the vertical position and hold it there. If we displace an ordinary pendulum to one side of the vertical position and release it, the force of gravity tends to pull it to a vertical position and to resist its going beyond that position, yet were the force ever so many times as great as it really is, it could never bring the pendulum to rest without the intervention of some extraneous force like friction or the resistance of the air.

The action of the synchronizing force between the alternators is analogous to the action of gravity on the pendulum. The synchronizing force tending to check the relative displacement between the generators exists only after the displacement has occurred; when the generators are in phase the force is zero, and consequently there is nothing to hold them there.

I believe I am saying something new when I make the assertion that in every practical case, the effect of the synchronizing force of the alternators is to *increase* the irregularity of the angular speed of the engine instead of to diminish it. On first consideration this proposition seems absurd, but, nevertheless, it is capable of being demonstrated practically as well as mathematically.

The matter first suggested itself to me some two years ago in connection with the paralleling of some alternator in which the synchronizing power was rather large. The synchronizing force in an alternator can be varied by increasing or decreasing the field current, and, in consequence, the voltage of the machine, and in these particular machines, which were of the two-phase type, the synchronizing force could also be greatly reduced by running the machines with only one phase connected in circuit.

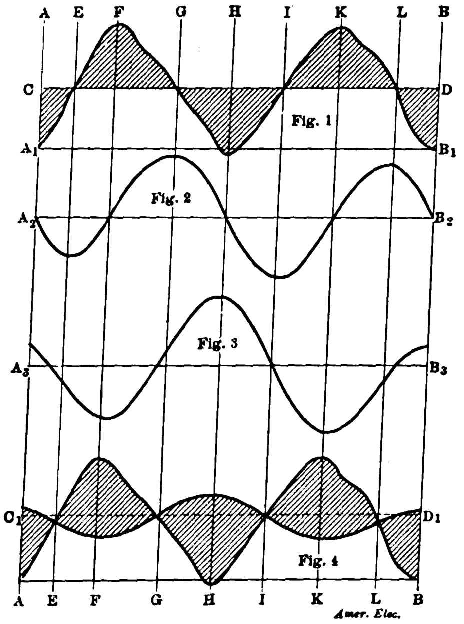
Some difficulty was experienced with the paralleling at the start, and a rather extensive line of experimental work was undertaken in the endeavor to locate the trouble and to overcome it. It was found that when the generators were run in single phase, they would parallel very satisfactorily, but when the second phase was cut in, the cross-current would increase, and quite serious transfers of energy would take place between the machines. At that time it was denied by electrical engineers of high standing that any two-phase machine would parallel more readily on one phase than on both; now, however, I believe the fact is freely admitted.

It was also determined beyond question, that by lowering the voltage to 80 per cent of the normal—or in other words decreasing the synchronizing force 20 per cent, the action of the machines in parallel was not open to criticism, even when running with both phases connected up. The repetition of these experiments a sufficient number of times to determine that the observed phenomena were not accidents, but were in accordance with some fixed law, made it quite apparent that, at least over the range covered by the experiments, the difficulties in paralleling increased with the synchronizing force of the generators.

Irrespective of whether a correction of the trouble could be effected by decreasing the sensitiveness of the governor, or improving the turning moment of the engine, or doing both simultaneously, the indisputable fact remains that with the original engine performance a variation of 20 per cent in the synchronizing power made the difference between success and failure in operating the generators in parallel, and this seems to indicate the utter fallacy of specifying the same characteristics in the engine for alternators in which the synchronizing force may differ by two hundred or even three hundred per cent.

The fact that the synchronizing force does, under all ordinary conditions, increase the angular variation in the engine may be shown theoretically in a general way without recourse to any abstruse mathematics. Fig. 1 represents a typical diagram of crank forces in a single-crank double-acting engine. The curve, A_1-B_1, represents the path of the crank pin for one revolution, and the ordinates of the curve represent to some chosen scale the tangential pressure on the crank pin at the corresponding point in the revolution; the area included between the curve and the base line A_1-B_1 represents the work per revolution in foot pounds.

The vertical distance, A_1-C represents the mean resistance of a uniform load reduced to the radius of the crank; and neglecting friction, the area of the parallelogram, A_1-C-B_1-D also represents the work per revolution in foot pounds. The shaded portions of the area included between the line *C-D*, and that part of the curve above the line represent in length the portion of the revolution in which energy is being stored up in the flywheel, and in area, the amount of this energy in foot-pounds. In like manner, the shaded areas below the line *C-D* represent the portion of the revolution in which the stored energy is being given up by the flywheel, and the amount of this energy.



FIGS. 1 TO 4.—PARALLELING OF ALTERNATORS.

While the crank is passing from *E* to *G*, the flywheel is absorbing energy and its velocity is increasing. Consequently at *G*, after having taken up the last foot-pound of available energy, the velocity will have reached a maximum, and will then begin to decrease from *G* to *I*, while the wheel is giving up energy, becoming a minimum at *I*; similarly other maximum and minimum points will be found at *L* and *E*. By mechanical integration of the curve in Fig. 1, referred to the base line *C-D*, we obtain the curve of Fig. 2. The ordinates of this curve measured from the base line, A_2-B_2, representing uniform mean velocity, indicate the velocity of the crank-pin above and below the mean velocity. The scale of these ordinates depends on the mass and radius of the flywheel.

Referring to the velocity curve, Fig. 2, it will be noted that the velocity is less than mean from *A* to *F*, and consequently at the end of this period, at the point, *F*, the crank pin will be at a maximum distance behind the position corresponding to uniform angular speed. From *F* to *H* the velocity is above the mean, and consequently at the point, *H*, will be a maximum distance ahead of the position corresponding to the uniform angular speed, and so on.

Integrating the velocity curve referred to the base line, A_2-B_2, therefore, a third curve, Fig. 3, is obtained, the ordinates of which curve referred to a base line, A_3-B_3, drawn midway between the highest and lowest points in the curve, represent the departure at any point in the revolution from the position corresponding to absolutely uniform angular speed. It will be noted that the displacement curve, Fig. 3, and the curve of crank-pin forces, Fig. 1, have a general resemblance in shape, in that each has the same number of nodes; but the nodes of one curve are directly opposite to those of the other. In other words, when the crank-pin effort is above the mean and the surplus energy is accelerating the rotating masses, these masses are always behind the position corresponding to uniform angular speed, and when the crank-pin effort is below the mean and the rotating masses are being retarded, these masses are always in advance of the position corresponding to uniform angular speed.

Now, consider the effect of the synchronizing force of the generators. For simplicity, assume that the engine-driven alternator is coupled in parallel with a number of turbine-driven alternators running at absolutely uniform speed, and that the total mass of these altenators is such that the synchronizing force can effect no appreciable change in their velocity. Whenever the steam-driven alternator is behind the position corresponding to uniform angular speed, the synchronizing force tends to accelerate the rotating masses, and whenever it is in advance of the position corresponding to uniform angular speed, the synchronizing force tends to retard the rotating masses. The intensity of these accelerating and retarding forces is represented at any point in the revolution by the ordinates of the displacement curve, the scale being proportional to the synchronizing power of the generator. It will, therefore, be readily seen that the synchronizing force acts *in unison* with the crank-pin force. During the period of the revolution in which there is a surplus of crank-pin effort, this surplus is augmented by the synchronizing force, and during the period in which there is a deficiency of crank-pin effort, this deficiency is also augmented by the synchronizing force.

This may be shown graphically as in Fig. 4, in which the crank-pin effort curve is reproduced from Fig. 1 and the line of load resistance instead of being represented by a straight line is represented by a curve of the same general form as the displacement curve, indicating the change in load during the revolution, due to the synchronizing force. The shaded areas in this diagram illustrate the unbalanced forces resulting from the combination of the crank-pin and synchronizing efforts. It will be noted that the unbalanced forces are very much greater than those due to crank-pin effort alone, and as these unbalanced forces are the cause of the departure from the position corresponding to the uniform angular speed, it is evident that whatever increases these unbalanced forces, will increase the variation from uniform speed.

The calculation of the exact amount by which the synchronizing force increases the displacement is a tedious and somewhat involved mathematical process. It is necessary to compute the displacement from the force diagram, and after finding the value for the synchronizing force, to construct a new diagram combining the two forces, and compute the displacement corresponding to the new force diagram. This process must be repeated until no appreciable increase in the displacement curve is found.

[The foregoing is an abstract of a paper read at the convention of the Engine Builders' Association held recently in Pittsburg.]

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ARE FREE LAMP RENEWALS DESIRABLE.

LEAVES FROM THE PERSONAL EXPERIENCES OF JAMES ENGLISH, F. E. SMITH AND W. J. GREENE.

JAMES ENGLISH.

Fifteen years ago, after careful consideration of this problem as it affected those companies that I was managing, and after some experimenting with the other method of charging for renewals, we adopted the plan of free renewals, and have found it beneficial and wise. A short experience in renewing lamps demonstrated the fact that if we were to do this work advantageously some definite system should be employed. The necessities of such a system seem to be that: (1) lamps should be renewed often enough to insure the lamps in service maintaining a given candle-power during that service, or a limitation in fall of candle-power; (2) the renewals should be made in such a manner as to cause no annoyance to the user; (3) renewals should be made often enough to obviate, practically, the necessity for customers ever calling for new lamps to replace those burned out; (4) the system adopted should be one that would effect the desired end in the most economical manner to the company.

Referring to the first requirement, we determined that a variation of two candles during the use of the lamp was as large as would allow satisfactory service. Testing soon demonstrated the fact that with 3½-watt lamps we could not get an average burning of over 400 hours and keep the lamp within the above limits. In the early days we did not in practice obtain such good results, but with the gradual improvement in the lamp we have reached a point where every lamp we put out can be relied upon to maintain its light within the limit. Starting at 16 candle-power they will all be at least 14-candle-power after 400 hours' burning.

We therefore adopted the policy that all lamps on our circuits should be changed once in 400 hours. It was quite clear that with a widely varying character of service if we changed all lamps at a given date we should remove many that had burned but a few hours and were good for many hours longer. It was equally plain that we could not assort these lamps in the places of installation, but we could bring all of them into the station and sort them by a photometer, discarding all lamps that were not 16-candle-power and putting in stock, to go out again, all that were 16-candle-power. This method we have followed in our different stations for over seven years. We change every lamp on our mains four times a year, usually in February, May, August and November. We find that this results in very few lamps having been used over 400 hours. We find that 4% of the lamps we have changed and brought in are 16-candle-power, and all right to go out again.

The results of this method have been fine, and the experience of ten years has demonstrated that all our lamps while in service are at least 14-candle-power, or not at any time during their service more than two candles below the initial candle power; that this method delights the users, who feel they are really getting something for nothing; that we no longer have occasion to send out lamps between the change periods, and rarely hear of a broken lamp; that the cost to the company of this method is at least no greater than that of the ordinary method of making free renewals; that the general effect on our business has been remarkably satisfactory; that our lighting is better than any I have ever had occasion to examine, and that we have now passed beyond the point of complaints of service, so much so that we rarely see or hear from a user, unless it be on the question of rates.

Generally, therefore, I have not the slightest hesitation in saying that in my opinion no electric lighting company can afford to do business in the old ways, and that the sooner lighting companies recognize the inherent weakness of the incandescent lamp itself, and devote their energies to attempting to obviate the ill effects of this fault on the business, the more successful they will be.

F. ELLWOOD SMITH.

I used to believe that a lighting company, whether it were a gas company or an electric light company, should own nothing whatever inside of a customer's building except the meter; that the customer should provide all the necessary shut-offs, pipes or wires, the fixtures, and the gas burners or the electric lamps. The business of a gas company being to furnish gas and that of an electric company being to furnish electricity, I claimed that the company's responsibility ceased when it had delivered the goods of proper quality and quantity at the meter. Theoretically, this may be true, but practically it is not the best method.

In my own experience, for a number of years I required my customers to buy all their lamps, either from the company at cost, or elsewhere if they saw fit. They usually saw fit to buy elsewhere, getting an inferior lamp for less money, or not buying at all, and thus not using the electricity. The customers know and care nothing about voltage and efficiency. I have found lamps used on our circuits consuming 5 watts per candle-power, and the customer thought he was getting a bargain when he bought this lamp for 15 cents instead of paying 20 cents for one of our lamps, which would consume only 3.1 watts per candle-power. Many a time I have found 110-volt lamps on our 104-volt circuit and customers finding fault because they did not get a good light. When customers have to pay for new lamps they will use the old lamps just as long as they will burn; and if one lamp does not give light enough, two must be used, and then the bill is large and the customer has a double kick: the light is dim and the bill is large. Under such conditions the result frequently is a notice to the company to discontinue the service.

Several years ago I retained a number of customers that were dissatisfied, by simply giving them a few new lamps and proving to them that the trouble was in the lamp and not with the current. The results were so satisfactory that I was converted to the free-renewal belief. It is impossible to educate customers so that they will buy good lamps when needed, and, therefore, in order to give good service the company must take the matter into its own hands and give free renewals.

The cost of the lamps is a necessary expense, just as much so as is fuel. A customer using a dim lamp giving, say, 12-candle-power, is paying for, say, 37 watts. Give him a new lamp giving 16-candle-power and consuming, say, 50 watts, and he will be satisfied with the light and willing to pay for the additional current. You will very soon get back the cost of the lamp and get an increased revenue and a satisfied customer.

I urge customers to change their lamps often, and if a lamp is dim to remove it. This request is printed on every monthly bill. We do not give lamps in exchange for broken lamps, and exchange free only 8, 16 and 24-c.p. lamps. We sell new lamps of these candle-powers to customers at ten cents each. We will get for customers any other style of lamp and charge them the actual cost to us.

I have not adopted the method of sending men to the customer's house and replacing his lamps, but I try to keep the dim lamps weeded out by circulars and notices on the monthly bills. This plan works fairly well, and I do not often have complaints of dim lights. I believe, however, that a periodical systematic renewal of all lamps on the circuits is a very good thing. All lamps returned are photometered, and if of sufficient candle-power are put into stock to be used again. We retain those giving 14-candle-power, and use them near the center of distribution, where the voltage is a little higher.

I do not believe in furnishing free the first installation of lamps, especially in residences, because in a great many instances, the return per lamp will be very small, and I believe that the cost of the first lamps will not keep away any desirable customers. Every company furnishing electric current for incandescent lighting ought, for its own good, to furnish free incandescent lamp renewals.

W. J. GREENE.

From 1888 to 1893, free lamp renewals were furnished by us. In 1892 it became evident that the net earnings were not keeping proper pace with the growth of the plant and the increased investment. In 1893 this condition became critical, and a change of some kind became imperatve. Two reforms were instituted: one, the adoption of a minimum charge proportional to the maximum-burning lamps; the other the discontinuance of free lamp renewals. The desired results followed. These changes were soon followed by the adoption of a two-rate system in connection with the minimum charge, so that consumers upon whom fell the heavier cost of lamp renewals were many times compensated for such expense by the lower cost of service.

The reasons originally advanced in favor of charging for lamp renewals were: (1) reduction in operating expenses; (2) consumers had been accustomed to maintaining equipments in all other methods of lighting, except arc lamps, and this company considered lamp renewals a legitimate expense to be borne by consumers. Nearly all of of our customers concurred in this view.

The reasons for continuing present arrangements until such time as local conditions may make desirable the furnishing of free lamp renewals, are: (1) the rapid increase of business, in the face of hard competition with gas, being difficult to provide for with increased capacity, owing to manufacturing delays and engineering difficulties, makes any check to growth, as may result from charging for lamp renewals, desirable; (2) lack of facilities, under present office arrangements, to carry a supply of lamps and conveniently serve customers with lamps from the office; lamps, supplies and construction work are furnished by local supply houses, who are, on the whole, furnishing customers with a good lamp at figures slightly in advance of cost; (3) advantages accruing to supply houses from handling lamps and the better service they can render us in return; (4) the avoidance of the extra time required on the part of the management, and extra cost of rental for storage room, labor and lamps.

[The foregoing is an abstract of a paper read at the recent National Electric Light Convention.]

Annual Convention of the American Institute of Electrical Engineers

The nineteenth annual convention of the American Institute of Electrical Engineers just held at Great Barrington, Mass., was one of the most satisfactory that the Institute has ever held. The convention opened with a reception given by the local committee in the assembly hall of the Berkshire Inn, at which several hundred residents of Great Barrington and vicinity were present to greet the members of the Institute. Mr. Wm. Stanley, chairman of the local committee, made a brief but extremely eloquent address of welcome, to which Mr. T. C. Martin responded gracefully. The following papers were read in the order given: "Method of Compounding Alternating-Current Generators and Motors, Direct-Current Generators, Synchronous Motor Generators and Synchronous Converters," by Prof. F. G. Baum, of Stanford University, Cal.; "Formula for Calculating the E.M.F. at any Given Point on an Alternating-Current Transmission Line," by Mr. Maurice Le Blanc, of Paris, France; "The New Generating Plants of the Niagara Falls Power Company," by Mr. Harold W. Buck, of Niagara Falls, N. Y.; "Notes on the Theory of Synchronous Motors," by Mr. Chas. P. Steinmetz, of Schenectady, N. Y.; "Experiments with Single-Phase Alternators on Two-Phase Circuits," by Mr. C. O. Mailloux, of New York; "A Study of the Heating of Railway Motors," by Mr. A. H. Armstrong, of Schenectady; "Method of Ascertaining by Means of a Dynamometer Car the Power Required to Operate the trains of the New York Central Railroad between Mott Haven Junction and Grand Central Station, and the Relative Cost of Operation by Steam and Electricity," by Mr. B. J. Arnold, of Chicago; "Comparative Acceleration Tests with a Steam Locomotive and Electric Cars," by Messrs. B. J. Arnold and W. B. Potter; "Notes on Railway Speed-Time Curves," by Mr. C. O. Mailloux; "The Predetermination of Alternator Characteristics," by Prof. L. A. Herdt, of Montreal, Canada; the Function of Shunt and Series Resistances in Lighting Arresters," by Mr. Percy H. Thomas, and "The Electrostatic Wattmeter in Commercial Measurements," by Mr. Miles Walker. There were also read papers by Profs. Samuel Sheldon and Wm. Esty, and Messrs. H. W. Buck and E. B. Raymond on engineering education, preliminary to which President Steinmetz delivered an interesting address on the subject.

METHOD OF COMPOUNDING ALTERNATING-CURRENT GENERATORS AND MOTORS, DIRECT-CURRENT GENERATORS, SYNCHRONOUS MOTOR GENERATORS AND SYNCHRONOUS CONVERTERS.

Prof. Baum's compounding system is shown diagrammatically in Fig. 1 herewith, where G is a generator from the shaft of which is driven an auxiliary machine, AA'. The armature winding a, a' of this latter machine is shown as a single turn of wire, one end being carried to a solid collector ring and the other end being connected to two circular segments, the two segments being interconnected electrically, as indicated by the dotted line. These segments cover about 90 electrical degrees each, so that the brush, b, is in contact with one terminal of the armature coil intermittently, during one-fourth of a revolution each time.

If the field magnet, AA', were excited by direct current, parts of an alternating wave would be obtained at the brush, a part of each wave being cut out owing to the fact that the ring is divided. If the field is excited by a sinusoidal alternating current in synchronism with the rotation of the armature, aa', waves of the e.m.f. are obtained at the brush of different forms depending on the position of the armature coil when the current passes through its maximum value. For example, if the armature coil passes the position shown when the current in the field coil is a maximum, it will be evident that there is a rectified potential at the brushes. The top of each wave is really cut off, and a potential given at the brushes which may be measured by an ordinary direct-current voltmeter. If the current in the field passes through zero when the armature coil passes the position shown, there is no rectified potential.

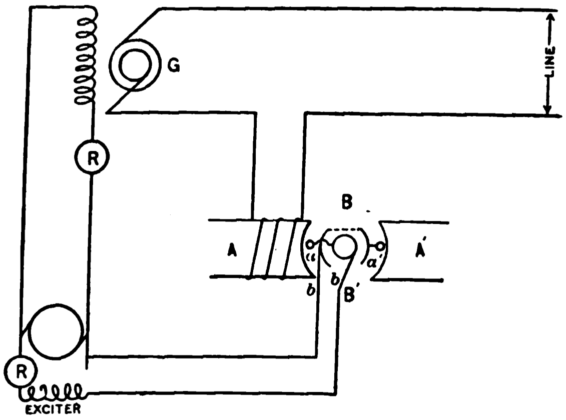

FIG. 1.—COMPENSATING SYSTEM.

The arrangement recommended for practice is shown diagrammatically in Fig. 2, and its application in Fig. 3. The rectified potential is used to excite a small direct-current generator of 100 to 500 watts capacity, and the armature of this machine is connected in series with the series winding on the exciter. The direct current is large, so that only a few turns are needed on the exciter. These may be easily threaded on by hand, if there is not already a series winding on the exciter, so that no new exciter is needed. The percentage of compounding may be changed simply by turning the rheostat handle in the armature circuit of the compensator. The compensator has four poles and is driven in synchronism by a gearing on the generator shaft. The compensator being small, it is a simple matter to add it to any generator.

This method may be applied to compounding alternators operating in parallel, whether the generators have separate exciters or are all excited from the same dynamo. When there is a separate exciter for each machine, the compensator may be applied to each generator, or a single compensator may be put on one generator and the current from the direct-current side carried around each exciter field. The station would then, of course, be compounded only when the generator to which the compensator was connected was running. The entire station may be compounded by a single compensator where all generators are excited from the same exciter. In this case, the current for the field of the compensator would be taken from the bus-bars. Since only a fraction of the exciting energy of the exciter is supplied the compensator of 500 watts capacity is large enough to compound all the alternators of a 10,000-kw. station.

Some of the advantages of this method of compounding are that the generators have but a single winding; no collector bus-bars, switches, etc., are necessary; no adjustment of low resistance shunts are necessary to make machines take their proper share of load; when the generators are over-compounded there is no drop in voltage when the brush machine is added. The amount of compounding may be changed instantly by turning a rheostat handle; the cost of compounding a large station will be less than compounding the same number of direct-current generators; owing to the absence of equalizer switches the operation of the station is simpler.

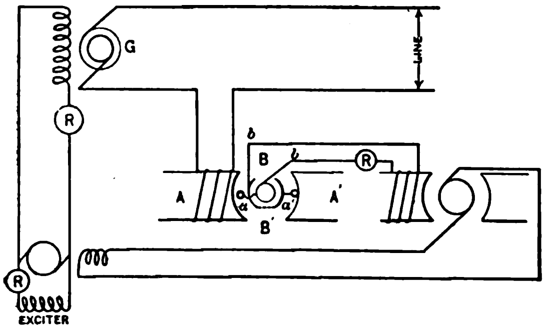

FIG. 2.—COMPENSATOR CONNECTIONS

The application of the method is given to compounding synchronous motors, direct-current generators, synchronous motor-generators and rotary converters. Its application is also given to the most general case of the transmission system with a long trunk line having several branch lines. In this case the generators are to be compounded for the center of distribution, and the synchronous motors on each branch line also compounded with respect to the center of distribution.

THE NEW GENERATING PLANT OF THE NIAGARA FALLS POWER COMPANY.

Mr. Buck's paper was a most interesting description of the new Niagara Falls plant, which consists of eleven 5000-h.p. generators of two types, six being somewhat similar to the external revolving-field machines in the old power house and five being of the internal revolving-field type, similar to the ordinary type of engine-driven alternator, except that the shaft is, of course, vertical. The generators of the external-field type are designed to give 10 per cent regulation, which is much closer than that given by the machines in the older power house, namely, 30 per cent. Another difference consists of placing the collector rings below the alternator instead of at the top of the shaft, and using centrifugal ventilation. All of the generators will run at 250 r.p.m. and deliver current at 2300 volts and 25 cycles.

The new turbines, while of the same general type as those in the older power house, differ in that they are of the internal discharge type and are provided with draft tubes which add 10 per cent to the effective head. The remaining capacity of the Niagara tunnel being 50,000 horse-power, the increase due to this better utilization of the water power permits of the use of eleven instead of ten units.

The exciter plant is located at the bottom instead of at the head of the pit, being installed in a recess and driven by a vertical turbine. Many changes have been made in the switching arrangements, there being only one board instead of two, as in the older power-house. Electrically-operated oil-break switches are employed, and switching is done by means of relay switches placed in such a relation to imitation bus-bars that the connections are clearly indicated—the real switches being on the power-house floor. Mr. Buck, in his paper, criticizes unfavorably the system of bench-board switch control.

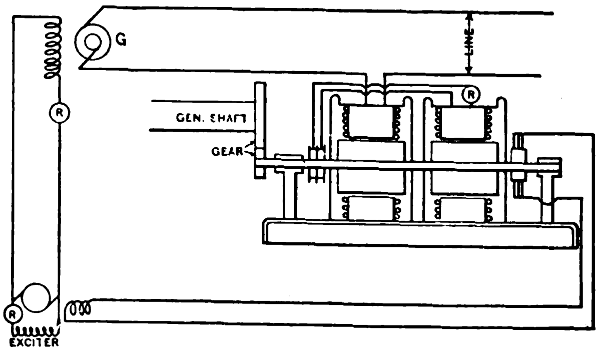

FIG. 3.—GENERAL ARRANGEMENT OF COMPENSATOR.

Instead of the ordinary time-limit relay, a device is used consisting of a dash-pot attachment to the tripping plunger of the circuit-breaker. This retards the movement of the plunger for ordinary temporary overloads, but if a real short-circuit occurs, the pull on the plunger is so strong that the dash-pot has no effect.

It is the intention to operate the 21 generators normally in four independent groups, but the arrangement of circuits is such that they may be all operated in parallel, or any one generator thrown on any group.

The paper also describes briefly the main features of the great plant to be erected on the Canadian side of the Falls, with an ultimate capacity of several hundred thousand horse-power. The units will be similar to the new Niagara design, above referred to, and of 10,000-h.p. each. They will be wound for 12,000 volts, three-phases and 25 cycles, at 250 r.p.m. The weight of the revolving part will be 141,000 lbs. and the diameter over all only 19 feet—the machines taking little more space than one of the older 5000-h.p. units. For long-distance transmission the voltage will be stepped up to 22,000, 40,000 and 60,000 volts, respectively—the latter to be the Toronto transmission voltage. The hydraulic features of the plant will be similar to the American plant.

NOTES ON THE THEORY OF SYNCHRONOUS MOTORS.

President Steinmetz's paper comprised the first section of a contribution to the mathematical theory of the synchronous motor. In the paper it is pointed out that synchronous motors—including the rotary converter—unlike induction motors, can at the same power output have the voltage, current, power-factor, etc., varied over a wide range by varying the field excitation—that is, the "nominal" induced e.m.f. As a consequence, this type of motor can be utilized to a considerable extent to control the phase relation, and thereby the voltage, while at the same time producing mechanical power.

The mathematical theory of the synchronous motor is developed, both graphically and analytically, numerical examples being solved to illustrate the application of the results arrived at. It is shown that with a given impressed voltage and current, the power output of the synchronous motor can vary over a wide range, and also that for each value of power-factor there is a corresponding value of lagging and a similar value of leading current. As excitation is increased the lag of current is decreased until it becomes in phase with the e.m.f.; and if further increased the current leads the e.m.f.

The second portion of the paper deals with the case of a motor not having constant speed, as when it is accelerated or retarded from any cause. This phenomenon of surging is designated electro-mechanical resonance, and is made the subject of mathematical analysis. The result shows that the frequency of oscillation does not vary much with the load and with the excitation, and that it slightly decreases with increase of load, and increases with increase of excitation.

The third part of the paper treats of the theory of damping devices and the final section considers means for avoiding surging. An external cause of surging may be the field of a self-exciting, direct-current generator, driven by the synchronous motor, and if the generator is also the exciter of the motor, the effect may be intensified. The governor of the prime mover may also act to cause surging. Internal cause may be found in the lag of the synchronous motor field behind the magnetomotive force. Appliances such as short-circuits ("dampers") around the field poles, while increasing the steadiness of a steady motor, will increase the unsteadiness of an unsteady motor.

The final conclusions are that the avoidance of surging requires consideration, first, of the design of the motor and the system on which it is to operate; second, of the use of anti-surging devices, such as a squirrel-cage winding in the field poles or short-circuits between or around the poles; third, a flexible connection, such as to a flywheel or by a belt to the load.

EXPERIMENTS WITH SINGLE-PHASE ALTERNATORS ON TWO-PHASE CIRCUITS.

Mr. Mailloux's paper described some interesting experiments with single-phase alternators connected to a two-phase circuit, the experiments being performed at the power station of the Phœnix (Ariz.) Light & Fuel Company, with a view to obtaining supplementary power pending the completion of another station. At present the company has a single-phase steam station in operation and a two-phase water-power station. In order to tide over until the second water-power station could be completed it was desired to operate the single-phase steam plant in connection with the polyphase water-power plant, and to this end the following experiment was made:

Arrangements were made for connecting the single-phase alternators each with one phase of the two-phase bus-bars in the substation. The necessary connections having been made, and a Lincoln synchronizer having been connected in, the experiment of coupling first one and then the other of the alternators in multiple with each of the two phases was tried, the alternator being brought to synchronous speed by regulating the engine throttle-valve. The next step was to connect the alternators to both phases. This was done easily. There was no difficulty in making the alternators keep in step and in making them carry a proportion of the total load. It was also found, as was to be expected, that the alternators could be utilized to balance the two phases in case they were unequal in potential difference owing to unequal loads.

The next step was to determine if two single-phase alternators could be maintained in two-phase relation by means of a two-phase rotary converter, when they were the sole source of the energy conveyed to the entire system. After careful consideration of all the reactions involved, the experiment was decided upon and the results justified the confidence with which the experiment was tried. The generators having been connected with the transformers and excited so as to give the full line voltage on the transmission line, the rotary converter was then started in the regular way. This having been done, the two single-phase alternators were then coupled in succession to the feeder bus-bars, one to each phase. In connecting each alternator, a Lincoln synchronizer was used as a phase indicating device. After the two alternators had been coupled, each to one phase, the connections of the synchronizer were then changed so as to show the phase relation between the two phases of the lighting feeder bus-bars. The instrument showed that a perfect quarter-phase relation was being maintained between the two phases, as was expected. The load on each machine could be adjusted, both by regulating the steam supplied to the engine at the throttle-valve, and by changing the excitation of the magnetic field.

After all adjustments had been completed the line switches were then quickly pulled open, thereby disconnecting the transmission line, and shutting off all electric energy supplied from the water-power station. At the instant of disconnecting, the speed of the rotary converter fell off slightly, on account of the fact that the throttle-valves of the engines were not fully open. On opening the throttles the speed rose gradually until the frequency again became about the same as it was before disconnecting the transmission line. The index of the synchronizer remained all the time at a point 90° from the position of synchronism, showing that the two single-phase alternators were being kept as perfectly in the same two-phase relation by the rotary converter as when the latter was run with current supplied from the transmission line. The external load was then varied by opening and closing the feeder-line switches at the lighting switchboard. The maximum load put on was equivalent to more than three-quarters of the full current capacity of each alternator; the load being composed almost entirely of incandescent lights the power factor was, of course, somewhat high.

After continuing the experiment for about ten minutes the alternating current switches of the rotary converter were opened and the single-phase alternators immediately lost step, the synchronizer having shown that the quarter-phase relation was lost at the same instant that the rotary converter was disconnected. The experiment was repeated with slight variations two or three times, and each time with perfect success. It was found that by opening the engine throttles somewhat more than was done in the first experiment, and increasing the steam pressure available at the engine cylinders before disconnecting the transmission line, there was less falling off of the frequency at the instant of disconnecting. It was observed that the alternating current in the rotary converter increased slightly, as was to be expected at the time of disconnecting the transmission line. This was, of course, due to the new inter-reactions taking place between the single-phase alternators and the rotary converter in consequence of the new function imposed upon the converter, that of acting as an electromagnetic coupling and flywheel for the two single-phase alternators. It was found that the amount of this current could be varied to some extent, as was to be expected, by varying the field strength of the rotary converter. There were no facilities for imposing a direct-current load on the rotary converter in addition to the load resulting from its operation as a phasing device for the two alternators. There is no reason to doubt, however, that a direct-current load could have been placed upon the rotary converter up to the full generating capacity of the two single-phase alternators serving as the source of current supply in the experiment. The experiment may, therefore, be taken to be a sufficient demonstration of the possibility of using single-phase alternators to produce two-phase current, three-phase current and direct current, with an arrangement and under conditions such as described.

The paper proceeds to discuss at length the reactions that take place in operation under the above conditions. It is concluded that the synchronizing force comes from the phase connected with the leading alternator, to the phase connected with the lagging one, the converter being an elastic coupling medium.

METHOD OF ASCERTAINING BY MEANS OF A DYNAMOMETER CAR, THE POWER REQUIRED TO OPERATE THE TRAINS OF THE NEW YORK CENTRAL AND HUDSON RIVER RAILROAD BETWEEN MOTT HAVEN JUNCTION AND GRAND CENTRAL STATION, AND THE RELATIVE COST OF OPERATION BY STEAM AND ELECTRICITY.

Mr. Arnold's paper was one of the most important and practical of all the papers read at the convention, and was substantially an abstract of the report made by the author to the New York Central & Hudson River Railroad Company on the problem of handling its trains electrically between the points mentioned. The paper describes the many tests which were made by Mr. Arnold. His calculations show that the electrical energy required to haul a ton a distance of one mile over that part of the road on which tests were made would be 63 watt-hours.

As a result of the investigation, Mr. Arnold recommended the direct-current system in combination with the third rail for the main line, and overhead construction for the yards. All of these elements have demonstrated fully their ability to meet the conditions imposed by railway operation so far as motive power is concerned, although there has not yet been an electric installation on any existing terminal that is as complex, or into which anywhere near the number of heavy trains enter, as on this section of road.

Had the length of road under consideration been considerably greater and had it been thought possible to secure sufficient time to conduct experiments or invite demonstrations by manufacturers of alternating-current motor-equipment, this class of apparatus would have been more seriously considered.

In the preparation of estimates, twelve distinct plans of generation and distribution were considered. All the estimates were computed upon the same basis so far as cost of fuel, labor and losses in transmission were concerned. The plan, which a careful study showed to be preferable, involves a combined direct and alternating-current power station at Harlem, run near one end of the line, with a rotary converter sub-station near the other end of the line, the transmission being at 11,000 volts, and the distribution 600 volts, direct. One storage plant is to be provided in or near the power-house and another at the sub-station, each of such capacity that it may, together with only a portion of the main station and sub-station machinery, take care of the entire load of the line for a short period in case of emergency.

The following figures are given as to the comparative cost of the steam and electric systems:

	Steam.	Electricity.
Operating expenses per locomotive mile, exclusive of fixed charges, but including water, labor, cost of cleaning and repairing tunnel, and all other expenses of locomotive operation	23.05	15.80
Fixed charges per locomotive mile, assuming that it now requires 40 locomotives to perform the present service, and that 33 electric locomotives could perform the same service	1.13	7.83
Total in cents	24.18	23.63

From these figures it appears that while there would be a slight annual saving in operating expenses in favor of electricity, it is not sufficient to warrant its adoption on the grounds of economy in operation alone, although its adoption can be justified on other grounds.

These figures could be made more favorable to electricity were an optimistic view of many of its advantages taken, and the probability is that practical operation will show a somewhat greater gain than here indicated, but Mr. Arnold deemed best a conservative view throughout the entire investigation. It is, however, safe to conclude that the saving in operation expenses by the electric system would be sufficient to offset the increased fixed charge due to the additional investment made necessary by its choice.

COMPARATIVE ACCELERATION TESTS WITH A STEAM LOCOMOTIVE AND ELECTRIC CARS.

The joint paper by Messrs. Arnold and Potter described a series of experiments made with a dynamometer car in order to obtain data for a comparison of steam and electric traction on short-haul suburban service. The locomotive used in the test was one designed especially for rapid acceleration, and the electric cars were two 35-ton motor cars of the type used in suburban service. A train of six cars, including five New York Central passenger coaches and the dynamometer car, were started and run over a mile of track, acceleration being made as rapidly as possible; on some of the runs the train was hauled by the locomotive, and on others by the motor cars.

The data, which are tabulated in full in the paper, bring out clearly the fact that electric motors during acceleration can utilize the weight on the drivers more effectively than locomotives. Owing to motors being able to maintain their maximum accelerating rate longer than the locomotives, they were able to cover the same distance in the same time with less energy expended and at less maximum speed. With a shorter run, the motor cars were able to make higher average speeds than the locomotive over its longer distance, and these higher speeds were also obtained with a lesser maximum speed.

On the basis of the energy per seat mile, the weight of the steam locomotive capable of perfoming the same service is considerably greater. For example, with six cars to a train, the watt-hours per passenger seat would be 43.9 with steam, and 29.7 with electricity, which figures become 187.8 and 45.2, respectively, for one car.

The paper gives the efficiency of an electrical system between boiler and track as 51.33 per cent, based upon the following component efficiencies: Engine, 90 per cent; alternator, 92 per cent; high potential transmission, 98 per cent; transformers, 97 per cent; converters, 92 per cent; third rail, 95 per cent; motors, including control; 75 per cent.

In the case of the locomotive, the coal per hour per effective horse-power is calculated to be 15.6 pounds. Assuming a consumption of 2½ pounds per h.p.-hour at an electrical power station, and 50 per cent efficiency for the motor, the corresponding figure for electric traction is 5 lbs. of coal. Assuming that the cost of coal for electrical power is one-third of the total cost, including maintenance and interest on investment, it is probable that the actual gross cost of electrical power would closely approximate the coal consumption of a steam locomotive in this class of service, the maintenance of the electrical equipment and attendance required being, however, considerably in favor of electrical power.

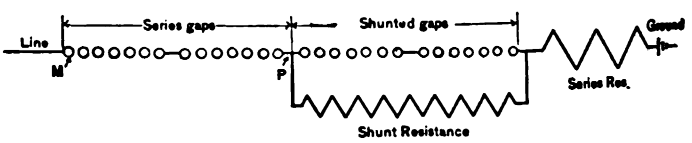

DIAGRAM OF LIGHTNING ARRESTER.

THE FUNCTION OF SHUNT AND SERIES RESISTANCES IN LIGHTNING ARRESTERS.

In this paper Mr. Thomas described a new method of suppressing the arc which follows a lightning discharge, and which would otherwise maintain a circuit for the station generator. The method involves the use of series and shunt resistances in connection with a multigap lightning arrester. The principle is illustrated by Fig. 1 herewith. When the arrester is not in action, the point *P* at the junction of the shunted and series gaps is at ground potential, and consequently the arrester will discharge whenever the voltage of the point *M* of the line reaches a potential sufficiently higher than that of the ground to cause the series gaps to break down; that is, the voltage on the line necessary to cause the arrester to discharge is that required to break down the series gaps alone, regardless of the presence of the shunted gaps. During actual discharge the series gaps break down, and the resistance between the points *M* and *P* is momentarily reduced to practically zero, and the full amount of the potential of the line is then thrown on the shunt and series resistances. If this potential, which is thus abruptly applied to the resistances, is high, the shunted gaps will be broken down. This makes, for the instant, a direct path for the static discharge from line to series resistance. If conditions are right, current from the generator will then follow the static discharge through the gaps, establishing an arc. The current will flow through the shunt and series resistances and usually through the shunted gaps, but if the various parts are properly proportioned, the shunt resistance will take enough current from the shunted gaps so that the arc cannot hold in the latter and will drop out. Once the arc drops out in the shunted gaps, it must pass through both resistances, which will reduce the current strength, and enable the series gaps to suppress it altogether.

The series resistance, though from one standpoint objectionable, is found necessary for the successful operation of the arrester, in order to prevent the enormous rush of current, which, on circuits of large generating capacity, would otherwise follow discharges and cause lights to dip and synchronous apparatus to fall out of step, as well as overheating the arresters themselves.

Mr. Thomas also explained in his paper the principles of the multigap and alloy cylinders in lightning arresters of the Wurts type, and gave the considerations governing the choice of shunt resistances. The paper concluded with a discussion of lightning arrester design and a description of a method of experimenting with the same.

THE PREDETERMINATION OF ALTERNATOR CHARACTERISTICS.

This paper, by Prof. Herdt, was a very long one, in which the author discussed indirect methods for the determination of the characteristics of complete alternating-current machines. Numerical and graphical data were given from a test of a 110-volt inductor alternator having a capacity of 15.4 kilowatts at 720 r.p.m. Three methods of determining alternator regulation were described, namely, the short-circuit characteristic method, the "composing magnetomotive force" method, and the "two reactance" method. In the case of the small inductor machine which was tested, the two-reactance method gave the best result, and the short-circuit method gave the next best result; in other tests, the most correct results were obtained by means of the two-reactance method.

THE ELECTROSTATIC WATTMETER IN COMMERCIAL MEASUREMENTS.

Mr. Walker's paper with the above title dealt with the application of the Kelvin quadrant electrometer to electric power measurements. Used as a wattmeter, this instrument reads the power correctly, whatever the shape of the wave form, because the turning moment at any instant is proportional to the instantaneous value of the power and the needle takes up a position that corresponds with the average of the instantaneous turning moments. The accuracy of the instrument on circuits of low power factors, its wide range and freedom from burning out make it suitable for general testing purposes whenever low power factors are likely to be met with.

When the power of a three-phase motor is measured in the usual way, with two successive readings on an ordinary wattmeter, one of these readings will be negative, or of very low power factor, when the motor is lightly loaded. It may be necessary to take the difference between two readings, both of which are inaccurate on account of the effect of the low power factor upon an ordinary wattmeter, and the final results will be very far indeed from accurate. On the other hand, an electrostatic wattmeter can be made to read power supplied at pressures as low as 100 volts. The author deduces the equations applying to this use of the quadrant electrometer and gives instructions for connecting up in different cases.

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GAS ENGINE PISTON RINGS.

BY JAMES F. HOBART.

Next to ignition, compression is the vital factor in gas engine work, and frequently faulty compression can be traced directly to the piston rings. Poor design, bad machining, and faulty fitting, are the three ills which rings are heir to, and one or more of these faults may be found to be the cause of nearly every case of piston leakage.

The most common form of ring, and about the worst possible, is shown by Fig. 1. This ring is concentric; that is, its walls are of the same thickness at every point of the circumference. The great trouble with this ring is that it will not stay round, no matter how perfect its shape may be when first made. After such a ring has once been sprung over the piston, it will not return to a true cylindrical shape. Fig. 2 shows the distortion of a ring of the kind mentioned. The distortion is exaggerated in order to make it more perceptible, but in a three-inch ring the distortion will amount to over 1-64 of an inch; more than sufficient to spoil the compression of the engine in which such a ring may be used. It will be observed that the ring bears against the cylinder wall only in three places, *a*, *b*, and *c*. Between these three points are openings of greater or less length and depth, according to the amount of distortion in the ring.

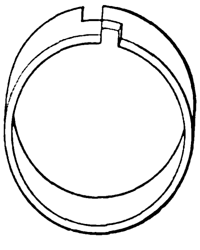
FIG. 1.

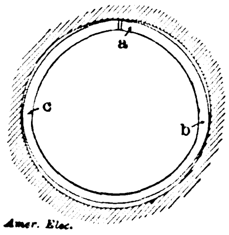

FIG. 2.

When a ring of this form is opened to slip it over the piston head, the force applied to the ends of the ring seems to take effect at a point about opposite the point where the ring is cut apart, or midway between *b* and *c*.

This effect is to be expected, for the ring becomes virtually a beam, supported in the middle (between *b* and *c*) and loaded at both ends. Therefore, according to the law of beams, the thickness of the ring should be increased at the point midway between *b* and *c*, in order that it may possess strength at that point relatively equal to the strength at any other point. Why the ring does not touch the cylinder at points between *a* and *b* and *a* and *c* is not so easy to explain, but a good idea of it may be obtained by trying to bend up a plain ring to fit inside a cylinder. It will always be found that the ends of the ring are too straight. They hit the cylinder before the part adjacent to the ends.

Without going further into the cause of poor bearing in parallel or concentric rings, it must suffice to state that they always fit as described, namely, with slight openings between *a*, *b*, and *a*, *c*, and a greater opening between *b* and *c*. Such being the case, a cure is necessary, and it is at once suggested that the ring be made thicker between *b*, *c*, and thin at the ends, *a*, where cut. The question now arises: how much should the ring be thickened in the middle, and thinned at the ends? According to theory, a piston ring should have no thickness where it is cut, and the thickness diametrically opposite should be sufficient to give the desired outward pressure to the ring. Figs. 3 and 4 illustrate this point. In Fig. 3, the thickness, *d*, is less than in Fig. 4, yet both these rings will fit perfectly in the cylinder.

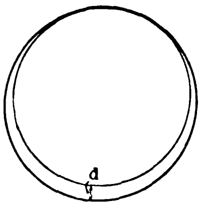

FIG. 3.

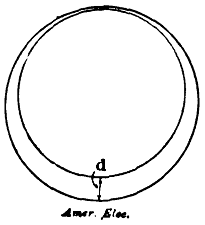

FIG. 4.

But it is necessary to have a certain thickness of metal where the ring is cut in order to make it tight in the piston groove; to this end metal must be added, as shown by the line *g*, Fig. 5. To a considerable extent all the metal inside of line *f* is useless for any purpose excepting that of giving a sufficient body of metal to fill the groove in the piston. Indeed, the presence of this metal at *e* is detrimental to the fit of the ring, but it is a necessary evil which must be accepted.

As stated above, a piston ring should be considered as a beam, supported midway between the ends at the cut and loaded uniformly. The load should be between 1 and 2 lbs. per square inch of exterior surface of the ring. Thus, by increasing the depth of the ring at *d*, Fig. 5, any desired pressure may be given to the working surface which bears against the cylinder wall. But with the ordinary snap ring there is another factor to be dealt with which confines the depth *d* within very narrow limits. This factor is the elastic limit of the metal of which the ring is made; as cast iron is usually employed for piston rings, it is obvious that the elastic limit must be very low. Consequently, the ring cannot be opened very far without causing it to take a permanent set and remain forever distorted.

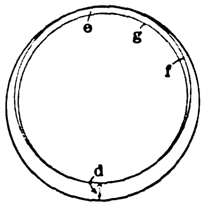

FIG. 5.

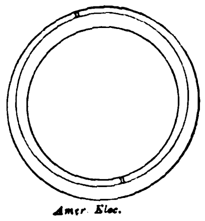

FIG. 7.

The amount of deflection which a piston ring will stand without losing shape may be closely calculated by the formula for helical springs, and it will be found that in order to spring over a piston the maximum thickness of a ring must be made so slight that it will scarcely give the necessary pressure against the cylinder wall, in small cylinders especially.

Measure carefully the distance between the ends of a piston ring, then stretch it upon the piston and again measure the gap; then snap the rig off of the piston and again measure. There are very few piston rings which will not show an increase in the length of the gap between the ends after being thus treated. Any increase in this distance surely means leakage past the ring, because any increase of the gap means distortion of the ring, which can only be corrected and the ring made tight again by the very slow and tedious process of running the engine until the ring wears down so as to fit the cylinder.

Removing a ring from a piston is apt to distort it much more than placing it in its groove; this is due probably to the fact that in putting on a ring it is forced gradually onto the piston, which keeps the ring in approximate shape, but when a ring is removed it is necessary to hang it up "neck and heels" by the two ends, and forcing bits of thin brass over the groove between ring and piston, until the former is free from the groove and may be pulled off the piston. In spite of all the care that can be taken in removing snap rings from a piston, it is impossible not to more or less distort the rings; consequently, a ring should never be replaced once it is removed from a piston. Therefore, the fitting of the ring and groove must be done so accurately that it is not necessary to try any ring in its groove, for the ring is certain to be damaged, if not ruined, by such a trial.

Small pistons should never have snap rings. The pistons should be made with followers and rings, so that the rings may be slipped in place over the end of the piston, and there held by screw or clamp followers. Such a piston would cost more than one fitted for snap rings, but it would be very much tighter, and compression troubles would largely disappear.

The cut or joint in a piston ring is another subject of greatly diversified practice, and efficiency also, among the makers of small-bore cylinders. In Fig. 6 several types of joint are shown, some of which possess alleged advantages over the other joints. At *A* is shown what may be called the conventional type of ring joint, although this form must divide honors with that shown at *C* and *D*. As to value, there is no difference between these joints. When properly made one is exactly as good as another, and when badly made all of them are worthless. In a certain make of engine, joint *A* is used, but the rings are all made to fill the grooves. Indeed, the rings are pulled tight and held by screws to the very bottom of each groove, and while in that position both piston and rings are ground to fit the cylinder. Rings of this kind, fitted as above, seemingly should ensure a very tight piston, but the pulling down of the ring against the bottom of the groove is apt to distort the ring more or less, so that when released from the screws, wear takes place on some portions of the circumference faster than on other portions and soon that occurs which is shown by Fig. 2, with the difference that while the ordinary ring gets better by wear the groove-filling ring gets worse for a long time before it begins to mend.

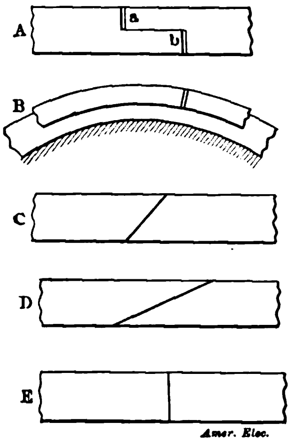

FIG. 6.—RING CUTS.

Regarding joints on eccentric rings; in all these, and in concentric rings as well, where there is space between the ring and the piston, the costly joint shown by Fig. 6 at *A* is no better than the plain cut shown at *E*. The reason is that in all rings having clear space inside them their tightness depends (other things being perfect) upon the distance between the ends where the ring is cut. If the ends at the two transverse cuts come together there will be very little leakage, but if there is a slight opening between the ring ends, there will be leakage due to a space having a cross-section as wide as the distance between the ring ends, and as long as the distance between the side of the piston and the wall of the cylinder. Thus, the diameter of the piston becomes a factor in the compression.

When there is space thus between and under the ring ends, it makes no difference about the close fit of the ring ends, for the reason that any gas which can get down under the ring at *a* can come out again at *b*, taking with it a certain portion of the compression. This being the case, it is just as well to cut directly through the ring as shown at *C*, using a small metal cutting circular saw or a thin milling cutter for the purpose. It is necessary to cut out just enough of the ring to allow the ends to touch each other when the ring is placed inside the cylinder. Thus, by varying the angle of the cut, more or less metal may be taken out of the ring as desired. The angle shown at *C* is the usual one for cutting rings, but more metal may be taken out by using an angle like *D*, or less, by cutting as at *E*, the amount taken out of the ring depending upon the angle given to the cutter.

In rings thus cut, there must be some leakage between the ends, a constant increase taking place as the rings wear smaller in diameter and allow the ends to spring farther apart. There is a way of reducing ring leakage to the least possible amount under all conditions of wear; to wit, by using the cut shown at *A*, Fig. 6, and placing another ring underneath it, as shown by Fig. 7. One ring is smaller than the other, and is turned to a good fit inside it. But these rings cannot be used with the ordinary piston, as it would be impossible to get the smaller internal ring over the head of the piston without distorting the ring irreparably. A loose or removable follower must be used, and with it the double ring will remain tight, no matter how far apart the ring ends may wear.

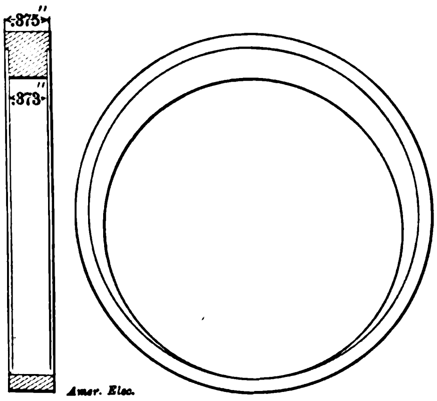

FIG. 8.—CONCENTRIC BEARING SURFACE.

In making piston rings the best machine work available should be used. The cylinder from which the rings is to be made should be bored and turned to size, and as each ring is cut off the next ring should be finished on one side, thus leaving only one more side or edge to finish. Next, clamp a ring upon a chuck jig and turn to the required degree of eccentricity, as determined by careful calculation. The diameter must have also been carefully determined, so that when a certain amount is cut out of the ring it will come down to the proper size with just enough material left outside for cleaning up after the ring is cut in two.

If an extra nice ring is made, bore the inside of the ring again, after cutting, and then chuck again and turn the outside to a finish. Do very little grinding to fit rings into the grooves. It is much better to spring them into a chuck and finish the sides down to less than .00025 inch, which can be readily done in a good lathe by a careful workman. Then but a very few rubs with a sheet of very fine emery-cloth will bring the ring down to size.

Cut the grooves in the pistons, and then turn the rings to fit. Make a very nice tool to the exact width required for the ring grooves, and use it only for one finishing cut in each groove. Work out the grooves to almost the exact width required, then finish with a single cut from the special tool, which will thus cut a large number of grooves, all of exactly the same width.

One more thing is necessary to make a nice wearing ring. When finishing the sides, or edges of a ring, cut back as shown by Fig. 8, all but a ring of a width equal to the thin part of the ring. Cut back the remaining portion about .001 inch on each side (as shown more clearly by the sectional sketch) so that when the final grind-fit is made, there will not be a thin portion on one and a thick portion to grind on the opposite side of the ring.

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An Extensive Interurban Electric Railway System.—The Hudson Valley Railway Company, which is a consolidation of several small interests, has now in operation over 100 miles of electric road running north from Albany and Troy to Saratoga, Lake George and the Adirondacks. At the present the power for operating the system is derived from power stations located at Stillwater, Saratoga, Middle Falls, Glens Falls and Caldwell, N. Y., but all of the power will ultimately be generated by a large station which is to be built near Waterford, on the Hudson River. For the operation of the road until the Hudson River power station is completed, a somewhat interesting method will be used. The company has increased the capacity of the direct-current power station at Glens Falls by installing a 250-kw direct-current engine-type generator and has increased the capacity of the Caldwell station by installing a 270-kw direct-current belted generator. In the power station at Glens Falls there will be installed a 250-kw Westinghouse rotary converter operating "inverted" (from direct to alternating) with raising transformers. Power will be transmitted by a three-phase 11,000-volt transmission line to Caldwell, where lowering transformers and a second 250-kw Westinghouse converter, operating as usual, will be installed to supplement the power of the Caldwell direct-current generating plant. At the power station in Saratoga there is to be installed a 400-h.p. engine and 250-kw 2200-volt Westinghouse alternator, with step-up transformers. From this station power will be transmitted by a three-phase 11,000-volt transmission line to a sub-station at Round Lake, where lowering transformers and a 250-kw rotary converter are to be installed. This sub-station will supply power to the recently completed Saratoga division of the system, connecting the main line at Mechanicsville with the Saratoga-Ballston line at Ballston Spa.

Annual Convention of the Independent Telephone Association

The sixth annual convention of the Independent Telephone Association of the United States was held in Philadelphia, June 24 to 26 inclusive, with headquarters at the Hotel Walton. The sessions were held in the Palm Roof Garden of the hotel.

The convention was opened by an address of welcome by Mayor Samuel H. Ashbridge, of Philadelphia, who referred to the beneficent influence that the independent competition had had upon telephone service and rates throughout the country, and paid high tribute to the Keystone (independent) Telephone Company, of Philadelphia. This company, he stated, is putting in a thoroughly modern system that will give Philadelphia the best telephonic facilities in this country when completed. He had been abused for signing the franchise bill for the independent exchange, but he didn't mind that. The Mayor closed his address with a hearty welcome and good wishes for the association.

Hon. S. P. Sheerin, secretary of the association, responded to the Mayor's welcome. Referring to the personnel of the association, he said: "We are about up to the average of American citizenship in morality and intelligence, and very much above the average in fighting qualities. This is not because we are naturally better fighters than other people, but because . . . our opportunities for fighting have been excellent." Mr. Sheerin said some complimentary things about Philadelphia, and closed by expressing the conviction that the delegates would carry away many pleasant memories, and the hope that they would leave similar memories behind them.

Hon. James M. Thomas, president of the association, then read his annual address, which opened with a quotation from the last annual report of the president of the American (Bell) Telephone & Telegraph Company, to the effect that independent competition is likely to continue "in some places" for some time to come, but while it has affected some Bell licenses disadvantageously, the consequences to the business as a whole have not been of serious moment. Judge Thomas agreed with the statements in the Bell report as to the effect of competition upon the business at large, and said that it had done more for the business than had been accomplished in the entire period prior to the inauguration of competition. The growth of the business has been marvelous, while the character of the service has been greatly improved.

The remainder of his address was devoted avowedly to a presentation of the status of the telephone business as it is to-day, and to pointing out a way of eliminating dangers to capital which come through mistaken promotion and ruinous rates. The telephone business requires more capital than is to-day at the command of the people who are at work in the building up of telephone properties, a stage that is always reached in the building up of great enterprises. Like all who work in a common business, we should, in view of this fact, give earnest consideration to the best means of relieving the situation.

The general money markets have not yet been opened up to the business. Large enterprises have been compelled to pay heavy tribute to the underwriter. There are some instances where the underwriters' profits have very greatly embarrassed the enterprise, and others where this is sure to come in time. If we have reached the period of building permanent investments, which we believe we have, then we must consider the best ways and means of building so as to be attractive to capital. The capitalist is always ready to invest in something sure and permanent, even though the returns are not very large. This being true, then somewhere in this field of investment there is something wrong, or else we could reach the money centers as well as local financial resources.

"If the great value of the telephone had been comprehended at the time of its discovery as it is now, capital would have undertaken to place it in the hands of the people in a way that would have spread its use more rapidly and more economically than was done in its earlier stages of development. But as all men are made of mud and slow of comprehension, we must take its slow stages of development as disclosing its weak and strong points."

The original investors in the telephone industry did not risk very much, but sought to reap returns from selfish and exclusive contracts providing for royalties and rentals even after the expiration of controlling patents. This, Judge Thomas thought, was one of the things that deterred capitalists from investing in telephone properties as readily as they should.

He argued for honest and fair methods, free from inflation, jobbery, bribery and unprofitable rates for estabished exchanges, and pointed out that there is no excuse for poor construction, inferior apparatus, overcapitalization, incompetent employees, or any other feature that may bring danger to the investor. All that is needed, he said, is to confess past errors and proceed as business men in all lines proceed, taking proper care of invested capital and using modern methods and economies in working out the plan. In conclusion he said that the association should not be governed by prejudice or preferences, but by justice and fair dealing; and he expressed the belief that this will be its policy.

At the close of Judge Thomas' address the session adjourned to 2 p.m., at which time there was a general introduction of delegates, followed by a most enjoyable tally-ho ride up the Wissahickon, in which a large majority of delegates participated.

The first paper read on Wednesday morning was on "The Telephone Situation in the Northeast," by Mr. L. A. Goudy, of Portland, Me. Mr. Goudy's paper consisted chiefly of a recital of the early struggles of his company, which had in the beginning a pretty stormy experience with the Bell interests, and some statistics concerning the company's present condition and that of the New England Bell Company. Mr. Goudy's company, the Northeastern Telephone Company, is the only absolutely independent long distance company in the field. It has liberal state charters from both Maine and New Hampshire, owns trunk lines which connect between sixty and seventy exchanges and toll stations in as many towns and cities, with 260 miles of pole line construction terminating at Portland. In conjunction with its connections with smaller companies, it has options on lines which will take it into New Hampshire.

The company has nearly one thousand subscribers, actual and immediately prospective and the demands are so great that it has been impossible to meet them promptly. Capital is the only requisite to enable it to become the strongest opponent of the Bell Company in the East. This the company expects to secure very soon, now that plans have become perfected for a large expansion of facilities. The Strowger automatic exchange system will be used for the larger exchanges, in conjunction with manual party-line service for long distance connections and smaller exchanges. A selective party-line device, which makes every subscriber's outfit private, has been successfully tested in some of the smaller exchanges.

Mr. Goudy then quoted the following section from the laws of Maine: "But no corporation organized hereunder shall have authority, without special act of Legislature, to construct its lines along the route or routes used or authorized to be used by any telephone or telegraph company, person or firm, or between points connected or authorized to be conducted by the lines of any such company, person or firm, unless it shall first obtain the consent of such company."

Mr. Goudy said that this statute was enacted about the time that the independent movement began, and he denounced it in scathing terms. Connecticut, he said, had been similarly imposed upon, but not to quite such an extent. The law as there enacted provides, substantially, that no competition shall prevail unless consented to by a judge of one of certain lower courts. He then criticized very severely the methods which had been used by the Bell Company to prevent or defeat competition, and reviewed at some length the history of the New England Telephone and Telegraph Company, accompanying the review with caustic comment.

In Massachusetts, he said, the companies using the Strowger automatic secret service system are making splendid showings, considering the short time they have been operating, and he expressed the opinion that the automatic system is far preferable to the central operator system, because of its feature of secrecy.

Situation in the Northwest

Mr. Goudy's paper was followed by one on "The Telephone Situation in the Northwest," by Mr. C. H. Judson, of Minneapolis, Minn. Mr. Judson stated that the independent telephone companies of the Northwest, particularly east of the Rocky Mountains, have made tremendous strides in growth during the past two years. Prior to that time the entire Northwest was the scene of the same peculiar business methods used by irresponsible promoters of independent telephone companies elsewhere. These men built extensively, but cheaply, but their day passed three years ago. Independent lines being built to-day, and those erected within the past two years, in the Northwest are built by men who expect to own and operate them.

The field in Minnesota and Dakotas has been a good one for the independents, as the Bell Company has only about sixteen exchanges in these states. When good independent exchange systems were built along the route of the Bell Company's long distance lines, the Bell people were immediately anxious to secure connections with the new exchanges; the Bell Company has built no new exchanges during the past five years in the states mentioned, but every town of 500 inhabitants or more has a telephone system, some of them reaching to nearby important centers, over independent lines excusively, and others partly over independent and partly over Bell lines. This arrangement has not been entirely satisfactory to the independents, as the Bell Company's policy has been to absorb the lion's share of the receipts; consequently new toll lines have been built, giving strictly independent connections between the large independent exchanges and outlying districts; other lines are planned for construction during the present and coming seasons, which will connect Minneapolis and St. Paul with all points in Minnesota and the two Dakotas, and will link with the splendid system of the Wisconsin independent companies.

The report of the Wisconsin Association gives the following statistics as to the independents in that state: 137 exchanges; 200 miles of copper metallic toll lines; iron metallic toll lines, 3000 miles; iron grounded toll lines, 4000 miles; toll stations, 650; telephones in use, 23,000; invested capital, $2,316,875. As the Minnesota Association has just been organized, it has been impossibe to gather complete statistics regarding the business in that state, but from present information they are as follows: Exchanges, 147; miles of long distance toll lines, 4000; miles of circuit, 7000, of which 1150 miles are copper metallic; toll stations, 725; invested capital, about $3,300,000; telephones in use, 34,000. South Dakota shows 103 exchanges, 2350 miles of toll lines and 450 toll stations; North Dakota has 80 exchanges, 1875 miles of toll lines, carrying 2750 miles of circuit, and 350 toll stations.

The largest independent company in the Northwest is the Twin City Telephone Company, operating exchanges in Minneapolis and St. Paul. The exchanges of this company are in active competition with Bell exchanges, and are giving a quality of service which probably cannot be excelled in the country. The construction, both aerial and underground, is of the very best, and the equipment and all materials are of the most up-to-date and efficient kind. In the underground work vitrified clay conduit is used exclusively, about 1,000,000 feet being now in use. The cables are from 200-pair down, built on the very best specifications, all of them being No. 19 B. & S. gauge double-wrap.

The company's system comprises seven exchange offices in the two cities, the extraordinary area of territory covered by the plant rendering branch exchanges necessary. The total ultimate capacity of the switchboards so far installed is about 26,000 lines; new switchboards will be installed next season, which will increase the ultimate capacity by 5000 to 6000 lines. Nearly 7000 telephones are in operation in Minneapolis and St. Paul, and new subscribers are being put in at the rate of over 500 a month. The company installs no party lines, but this has no effect on its earning power, nor upon its business prospects, since the party line users are of comparatively little importance commercially. The company has installed a large number of private switchboard systems, and maintains a special department for the installation and care of this class of work. The investment in the plant thus far is over $2,000,000.

The Zenith City Telephone Company, of Duluth, is the second largest independent company in Minnesota. The company has at present 1900 subscribers, and is unable to keep pace with the demand. The People's Telephone Company, of West Superior, Wis., is closely allied with the Zenith City Telephone Company, and equally prosperous. These two companies are connected with the Twin City Telephone Company, of Minneapolis and St. Paul, by a long distance line comprising three metallic circuits of No. 10 copper wire, which line belongs to the Consolidated Telephone & Telegraph Company, composed of officers of the Twin City Company. The company is doing a very satisfactory business, and has about twenty-eight stations on its line.

The Consolidated Company has material on the ground for the construction of a line between St. Paul and Eau Claire, which will connect with the Wisconsin system at the latter point. Also a line to La Crosse, Winona and intermediate points; this line will feed a large number of lines which have connections with the twin cities, and will probably get 100 toll stations and 25 exchanges from these lines. All of the lines are of the very best copper construction; the company builds no iron wire lines, except for the occasional accommodation of a few small exchanges for local business only.

The United Telephone & Telegraph Company, with headquarters in Minneapolis, operates about 250 miles of lines which have connection with the Twin City Telephone Company and pass through three of the largest towns in which the Northwestern Telephone Exchange Company has exchanges.

Perhaps the most successful independent company in Wisconsin is that of Madison; the Bell Company does practically no local business there, and if the independent company had proper circuits through the state there would be no business for the Bell Company to subsist on.

Farmers' lines in Minnesota are taking hold well; one company having over 400 farmers' instruments connected up, and increasing constantly.

Portions of the Northwest demand telephone service because of the long distance between railroad stations and their inaccessibility at certain seasons of the year. In these districts it has been found difficult to make a good line pay at present, but the telephone has been found to be an active agent in the settlement and building up of a new country, and men of means and energy are at hand to extend the system, which Mr. Judson considers is the most valuable adjunct to frontier and backwoods settlements. Fortunately, many of these districts supply plenty of good cedar poles immediately at hand, making the construction cheaper to a great degree than in the more settled districts.

The Thursday morning session was opened with an address from Mr. Thomas Martindale, chairman of one of the local trades bureaus.

At the close of Mr. Martindale's remarks there was read a paper by Mr. L. J. Hackney, of Indianapolis, Ind., the title of which was "Where We Were and Where We Are." Mr. Hackney's paper, like those previously read, comprised a general review of the telephone situation in his district prior to the inauguration of the independent movement, and a comparison of that situation with the one of to-day. Before the expiration of the fundamental patents, he said, many of the fairly large cities of the country had either no telephone service at all or very small and indifferent plants. The smaller cities and larger towns had never been supplied with telephone service nor could they obtain it under any inducements whatever. Such a thing as telephone service to a farmer would have been regarded as a huge joke by the parties then controlling the telephone industry. The origin of the independent movement, he said, was due not so much to the desire of persons to enter into the telephone business as to the demand for telephones from people who had tried in vain for ten years to obtain srevice from the Bell Company. It was no trouble, especially in the West, to organize a telephone company and have all the stock paid up in a night. That is why the independent telephone business has the smallest bonded indebtedness of any business in the country. It is an enterprise in which all the people co-operate to get the service from the Bell Company. It was no as to the details of co-operation. The Bell Company in Indiana (the Central Union) antagonized the people by discontinuing a number of exchanges when the legislature of 1883 passed laws regulating telephone rates, and, as a result, the people of those towns and people of towns which already had Bell service were eager for any opening for competition, so that when the independent movement began it found a fertile field in the state of Indiana.

The state now has over 70,000 independent telephones, about 6000 miles of excellent toll line, and an enormous mileage of country lines built solely for farmers' service. The total indebtedness of the telephone properties in Indiana does not exceed 5 per cent of the total cost. There is an independent telephone plant either in operation or under construction in every important city and town in the state except Evansville, and work will be started there shortly.

The prediction by opponents of the independent movement that an independent exchange could not be successful without long-distance (interstate) connections has been effectively disapproved. Of all of the telephone messages originating in the state only 2½ per cent go beyond its borders. It has been found also that about 89 per cent of all messages originating at any given center are confined to a radius of about 35 miles. In conclusion the author pointed out that the first requisite to independent development is to have good exchanges in the cities and towns, occupying the whole field and giving telephone service to everyone who wants it. Next after this in importance comes a good system of toll lines. He also expressed the belief that no telephone company can succeed without local financial interest and local management. It would be just as easy and just as sensible to undertake to manage the street and sewer work of an Indiana town from Boston or to have the school trustees and teachers appointed from New York as to operate successfully a local telephone plant from either of those places.

After the reading of Mr. Hackney's paper, Mrs. Annie McElroy I rett delivered an interesting impromptu address relating her experiences in organizing and operating an independent telephone exchange in El Paso, Texas, and recited some amusing anecdotes concerning the struggle with the local Bell representatives. When Mrs. Brett began operations her highest ambition was to obtain 600 subscribers; the number actually obtained thus far is 1500.

Needed Improvements

Mr. L. W. Stanton, of Cleveland, Ohio, then read a paper on "Needed Improvements in Independent Telephony," which was the only paper relating to practical operation that was presented at the convention. Mr. Stanton pointed out that while public sentiment has heretofore been a prominent factor in the success of the independents, it is becoming more and more apparent that the company giving the best service and the most courteous treatment will secure the business. The public has favored home companies on account of their origin and the conditions under which they originated, but the time will arrive when the independent companies must demonstrate their ability to furnish as good or better service than their competitor; the company furnishing the best service to the greatest number at an equitable rate will unquestionably do the greatest business. For the independent companies to bring about such conditions requires a far-reaching revision in their present tariff system, a change in their engineering and equipment, and attention to traffic details hitherto ignored.

In larger cities there are thousands of families and hundreds of small tradesmen who cannot afford to pay the minimum flat rate for individual service nor can the telephone company afford to reduce that rate; the inevitable result is party line and measured service. With a good system of selective four-party lines, with the traffic details well worked out, this service for the small user is almost as good as individual service. The contention that this works injustice to the subscriber who has individual service is erroneous. The individual-service subscriber in ninety-nine cases out of a hundred is glad to be able to telephone to subscribers on party lines.

With relation to the financial aspect of party-line service, Mr. Stanton presented a chart which is reproduced in Table I herewith. The figures on which his argument is based are given in the table. Reference to this table shows that upon doubling the number of telephones on a line and decreasing the rate one-fourth, the *net* revenue per instrument is decreased and the net revenue per line increased; but it is most notable that the net percentage of earning on the investment per line is greater for the four-party line than any other, the next highest earning being shown by the two-party line. A point that should not be lost sight of in establishing party-line rates is that a dollar or two of difference in the rate makes considerable difference in the net percentage of earning on the amount invested, as is indicated by the showing for four-party and eight-party lines.

TABLE I.—COMPARATIVE DATA PARTY LINE SERVICE; 4000-LINE EXCHANGE.

No. of Parties per Line.	Av. cost per Line	Service Rate	Rental per Line per Year	Cost to Operate per Line	Interest on Investment per Line	Depreciation per Line 10%	Total Cost Opr. Int. & Deprec. per Line	Net Earning per Line	Net Earning per 'Phone	Net Per Cent Earned on Investment per Line
1	$100	$48	$48	$15.00	$5.00	$10.00	$30.00	$18.00	$18.00	18%
2	125	36	72	22.50	6.25	12.50	41.25	30.75	15.62	24.6
4	175	27	108	37.50	8.75	17.50	63.75	44.25	11.06	25.29
		24	96					32.25	8.03	18.43
8	275	20	160	67.50	13.75	27.50	108.75	51.25	6.41	18.6
		18	144					35.25	4.40	13.

There are three principal objections to the party line, namely, the annoyance from the ringing of the bell when some other station is wanted, the frequent report of "line busy," and the fact that the surface is not private. The first objection can be almost entirely eliminated on party lines of four subscribers or less, provided the equipment is of the proper design and the operating is good. The second is a more difficult problem. If the subscribers have unlimited service the line will frequently be busy, and in order to limit this some form of measured service will be necessary. Automatic apparatus, either at the telephone or on the switchboard, is not satisfactory, for in case the line that is called for should be busy, the call would be registered without giving the calling subscriber any service. With either a meter or a slot machine at the subscriber's instrument the service is retarded, for the operator must remain on the line until the particular person desired at the called station has been secured and the calling subscriber has registered or deposited the required coin.

The system in use in a number of the largest Bell exchanges and one which gives the best general results is where the operator marks down the telephone number of the calling subscriber and then draws a line through the number in case the call is not completed. The sheets containing the record of these calls are collected and sent to the billing department every hour. Measured service handled in this way gives a subscriber very prompt and efficient service, and when used in connection with a four-party line will give excellent results.

The secrecy or privacy of a properly designed party-line instrument is almost equal to that of an individual telephone. With a lamp-signal board and selective ringing apparatus the different parties on the lines have no means of knowing when some other party is calling or being called, and if a line is in use the user can readily hear another party come in on the line and suspend conversation until the line is clear. Up to the present time the call for special party-line equipment has not been very great and independent manufacturers have not given the subject the attention that it should receive in the future. A four-party selective system which depends upon the frequency of the signaling current has been devised and seems to possess points of superiority over the pulsating bell arrangement which has been used by the Bell Company. Before party-line service can become thoroughly commercial the manufacturers will have to revise their equipment design. With present arrangements either one or both sides of the line are permanently connected to the central battery, which is grounded; this makes four-party selective signaling very difficult if not impossible.

One of the greatest needs of the independent telephone interests is for this association or a kindred association to take up in a technical way the practical subjects of traffic, engineering and equipment. Thousands of dollars are being wasted through ignorance which could be saved by such action. There is no other progressive art in which the practical exponents do not come together and discuss the practical and technical problems which are sure to arise, and in such an industry as telephony it is particularly desirable, for in no other industry does the equipment and welfare of one company so intimately affect another.

The author's experience on the United States Telephone Company's long-distance lines is that when 20-volt and 40-volt common battery systems made by different manufacturers are connected the results are unsatisfactory. In one case where a 40-volt system was installed the toll business at that place was almost lost for a period owing to the inefficiency of the system for long-distance work. The trouble was not due to either of the voltages, but to the fact that the system was improperly designed for receiving incoming toll business. This illustrates why telephone apparatus should be standardized; until the independents adopt some standard equipment they will necessarily give an inferior class of toll service.

If a traffic and engineering association were formed, there are many details of traffic and engineering on which articles should be written and thoroughly discussed, which would be of inestimable value to the independent movement. The problem of giving long-distance service makes such action doubly necessary. If the long-distance trunk lines are to be built by different companies, they should consult each other, decide upon the class of construction and equipment and, more important yet, upon the location of their relay and switching stations—that is, the points along the trunk lines where testing for trouble is done, where operators are located for switching purposes, and where telegraph apparatus, such as relays, repeaters, batteries, etc., are located for handling leased wire work (telegraph service over the telephone lines). These stations should be located at intersections of the east-and-west and north-and-south trunk lines.

Situation in the West

A paper on "The Independent Telephone Situation in the West," by Mr. C. E. Wells, of Marion, Kans., was then read by Secretary Sheerin, Mr. Wells being absent. Mr. Wells' paper opened with some extremely humorous references to telephone men in general and to the state of Kansas, from which he hails. Settling down to a serious vein the author stated that the first independent exchange that had ever failed in his state of Kansas was the Topeka plant, which shortly succumbed to the Bell opposition and failed. This, however, was the only independent exchange that had ever failed in his territory. The independent movement there, as is the case generally elsewhere, began in the smaller towns which had not had any telephone service prior to the inauguration of the independent movement. At the present time every city in the state except Lawrence and Kansas City is occupied by independent exchanges; a franchise is now being negotiated at Lawrence with the prospect of favorable action, and Kansas City will be served by the independent exchange in course of construction at Kansas City, Mo.

The Kansas Independent Telephone Association, with a membership of some sixty companies, had in operation at the time of the last report nearly 19,000 telephones, which Mr. Wells estimated to represent about 60 per cent of the total number of independent instruments in use in that state. This makes a showing which he considered conservative, of six telephones in use by independent companies to every Bell instrument. There are comparatively few farmers' lines, but taking these into consideration, the total number of independent telephones is ten times the number of Bell instruments. The author expressed the opinion that the success of the independent exchanges has been due in a considerable measure to the fact that the local independent toll lines cover the territory so thoroughly. While few distinctively long-distance independent lines have been built so far, there is scarcely a post-office or hamlet that is not reached by the local toll lines.

In the state of Nebraska the independent movement has not reached the magnitude that it has in Kansas, but the companies there are very aggressive and there has been unusual activity during the past year.

In closing his paper Mr. Wells expressed the opinion that the independent telephone interests have much more to fear from internal dissensions and jealousies than from the competition of the Bell Company, and for that reason harmony should be fostered.

A paper on "The Financial Status of the Independent Telephone Movement," by Hon. H. D. Critchfield, of Cleveland, Ohio, had been scheduled for this convention, but Mr. Critchfield having been unable to prepare his paper in time secured the consent of the convention to waive the presentation of it at the meeting and allow him to prepare the paper later and make it a part of the association's records.

On invitation of Judge Thomas, president of the association, Prof. W. E. Goldsboro, of Purdue University, delivered a short address in which he outlined the course in telephone engineering which his university is just about to establish.

At the opening of the afternoon session the officers for the ensuing year were elected as follows;

President, Judge James M. Thomas, Cleveland; first vice-president, Hugh Dougherty, Bluffton, Ind.; second vice-president, C. E. Stinson, Rochester, N. Y.; third vice-president, W. H. Durin, Cedar Rapids, Iowa; secretary and treasurer, J. B. Ware, Detroit, Mich.; first assistant secretary, C. E. Wilson, Philadelphia; second assistant secretary, E. L. Barber, Wauseon, O.; third assistant secretary, T. B. Lee, Pittsburg, Pa.; Advisory board, J. M. Thomas, S. P. Sheerin, H. Dougherty, H. D. Critchfield. E. B. Fisher, S. E. Wayland, W. B. Seaton, G. W. Beers, H. C. Young and E. E. Webster, the last two being new members.

The convention then adjourned and most of the delegates participated in an excursion to Atlantic City.

Abstracts from Foreign Contemporaries

New Selector System.—A selector system whose primary application is the control of sub-station and arc-light circuit switches from the main generating station has recently been developed by Louis N. Bruner, and, according to the London *Electrician*, has been in use for upwards of nine months at the Croydon Electric Works. The transmitter which is placed in the central station is shown by Fig. 1. A number of pairs of brass discs, *D*, are mounted on a spindle, *S*, which rotates one revolution when a handle is pulled forward and released; a spring pulling the lever back drives the spindle through an ordinary train of wheels. While only one pair of discs are shown in the diagram, in practice there are as many pairs as there are distant switches to be controlled. Each of the discs has a number of projections on it which make contact with the springs, *F, F*. Every time a contact is made, the circuit is closed through one of the electromagnet coils, *E*. These electromagnets act as relays, and when their armatures are attracted, they close the contacts, *C, C*, of the selector circuit, sending a positive or negative current to the line. Each of the different pairs of discs, *D*, corresponds to one selector on the line, and each pair of discs sends a number of impulses in one direction and a smaller number in the reverse direction; but the moments at which the reverse impulses are sent between two ordinary impulses, differ for the different pairs of discs. Each of the selectors on the line is so designed that the corresponding switch is only actuated when this particular series of impulses is received. A sketch of the selector is shown by Fig. 2. An electromagnet, *A*, is placed between the two poles of a horseshoe magnet, and it is free to move either to the left or right, according to the direction of the current passed through it. Each time it is attracted to the

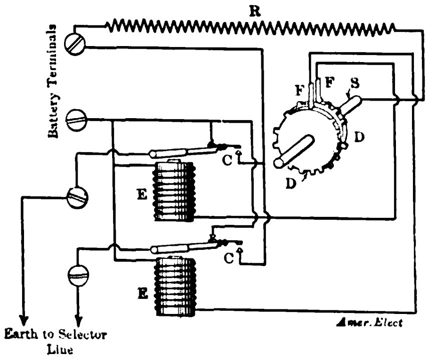

FIG. 1.

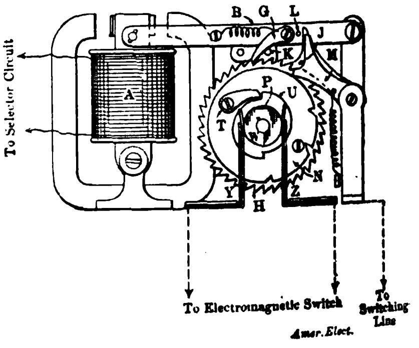

FIG. 2.

left it pulls with it the link, *B*, and the pawl, *G*, pushes the ratchet wheel, *H*, one tooth forward against the action of a spring. The detent, *J*, which is also kept bearing on the ratchet wheel by a light helical spring, prevents the wheel turning back. After a number of impulses attracting *A* and *B* to the left, a reverse current is received from the transmitter, as already explained. The arm, *B*, then moving to the right, *G*, comes in contact with the pin, *K*, and is lifted, and the pin, *L*, engages with the detent, *J*, and releases the ratchet wheel. This is what happens if the transmitter slider is not adjusted to the selector in question. If, on the other hand, the series impulses received are those for which the particular selector is intended, a second detent, *M*, is engaged in one of the notches in the plate, *N* (which is fixed to the wheel, *H*) at that moment, and prevents the wheel from returning to its initial position. On the same spindle, but loose on it, is a small barrel of vulcanized fibre, *W*, to which is fixed a small brass plate, *P*, and a snail, *U*, with two notches at opposite diameters. A pawl, *T*, fixed on the larger snail wheel, *N*, engages in one of the notches in *U* after the wheels, *H* and *N*, have made a half revolution forward, and the next impulse being a reverse one, the barrel, *W*, revolves back with the other wheels. In rotating, the plate, *P*, makes contact with one of the flat springs, *Y* or *Z*; this closes the circuit of either the switching on or switching off coil of an electromagnetic switch on the circuit or transformer which the particular selector controls.

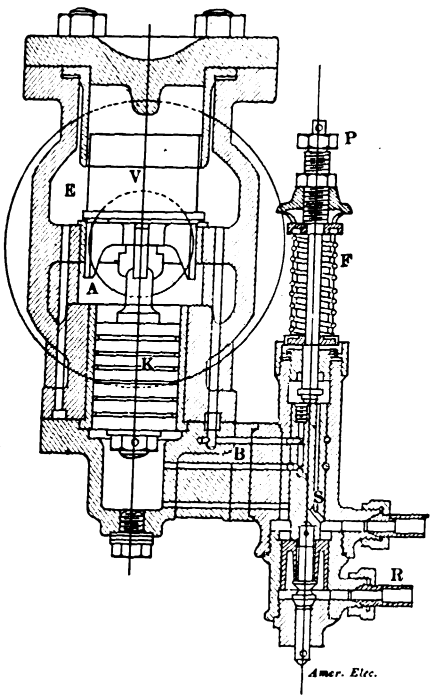

FIG. 3.—PUMP REGULATOR.

Steam Pressure Regulating and Automatic Cut-off Valves.—According to London *Engineering*, the Deutsche Waffen und Munitions Fabriken of Berlin manufacture a novel kind of valve for regulating the pressure in steam pumps, for reducing steam pressure and for automatically cutting off the supply of steam in case of any accident. The valve for regulating the pressure in steam pumps is shown by Fig. 3, herewith. It cuts off the steam supply when the adjustable maximum pressure is reached in the feed pipes, and starts the pump again when the water pressure, which is likewise adjustable, falls below its normal value. The operation is said to be so rapid that no intermittent action ensues. The apparatus is fixed on the steam pipe between the cut-off valve and the pump. Steam enters the valve at *E* and passes through the bored ports *B* to the underside of the piston *K*, which is loosely connected with the valve *V*. When steam is turned on, the piston *K* is lifted and the valve *V*, which is partially balanced, is opened. The slide *S* is controlled by the difference between the hydraulic pressure in the pipe *R*, and the pressure of the spiral spring *F*. When the water pressure overcomes the spring pressure, the slide will be raised and communication through the several ports *B* be broken. Any steam not yet utilized is forced out through *B* and no further steam can enter under *K*; the valve *V* being thus closed, the pump would be stopped. In reality, however, the openings and closings of the valve will succeed each other so quickly that the valve *V* and the slide S will assume an intermediate position in accordance with the duty of the pump. The pump will therefore work without knocking, automatically regulating itself.

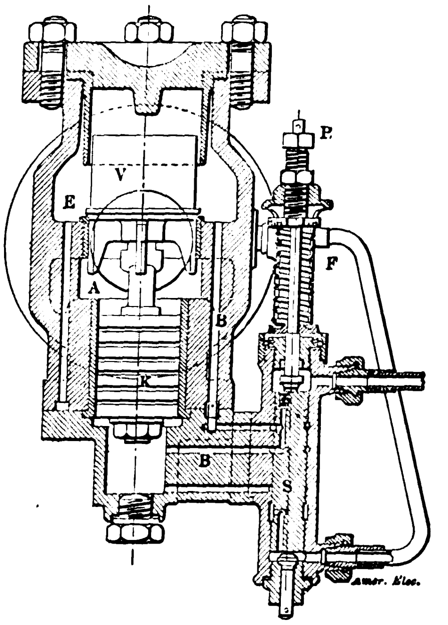

FIG. 4—PRESSURE REDUCER.

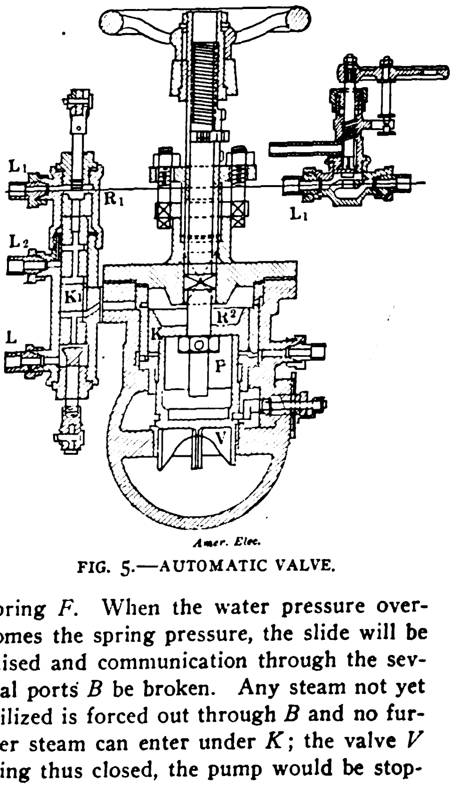

FIG. 5.—AUTOMATIC VALVE.

The pressure-reducing valve is shown by Fig. 4, and resembles the valve just described in its main features. Instead of the hydraulic pressure the low-pressure steam acts upon the slide *S* against the spiral spring, and when this force is overcome the high-pressure steam can no longer enter. Practically a state of equilibrium will be established as in the former case.

Figs. 5 and 6 show the automatic cut-off valve, which serves several purposes. Steam is admitted with the aid of a hand wheel, and in cases of emergency may be instantly shut off by pulling the lever chain *S*. Auxiliary pipes, containing three-way cocks manipulated by levers, are taken to all of the spots from which the engine is to be stopped; and the apparatus operates automatically should the steam pressure be abruptly diminished. The flange *E* is on the boiler side, the flange *A* joins to the steam pipe, and the several connections *L*, Fig. 5, are screwed in and soldered; *L* itself annunciating with the boiler, L_1 with the cut-off valve of the engine and L_2 with the exhaust. When the apparatus is in the closed condition, steam will have entered through *L* into the chamber R_2 and the valve *V* will be shut. To start the supply the chain or cord *S* is pulled. The piston valve K_1 previously, raised by the boiler pressure will travel downward, and the steam confined in R_2 will escape through L_2. At the same time the valve *V* will be opened, and steam admitted through the pipe L_1 into the chamber R_1, keeping the piston K_1 down. The boiler pressure under the piston valve *V* will force the valve against its seat *P*, and if the chain *I* be pulled the small piston K_1 will be raised by the lever *H* and no steam will be able to escape from above the large piston *K*; while the boiler steam will pour in through *L*, forcing the piston *K* down upon its seat. The same movement will take place if the steam pressure on the engine side should suddenly fall. In that case R_1

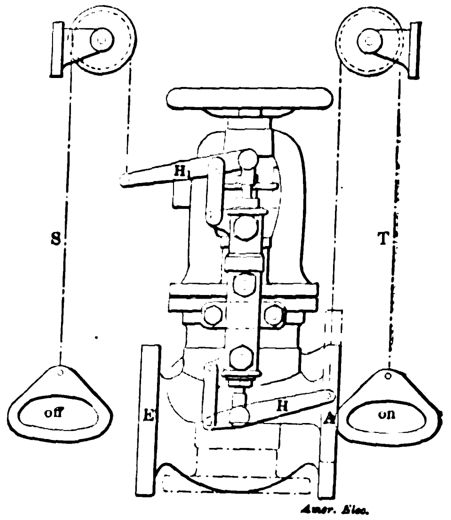

FIG. 6.—AUTOMATIC VALVE.

will be brought in communication with the atmosphere and the pressure on the upper face of K_1 being thus removed, it will again be pushed upward, while the boiler pressure will fill R_2 and keep K forced down on its seat, entirely shutting off the boiler steam. The advantage of this apparatus is that full boiler pressure operates the valve, whilst similar apparatus has, as a rule, to depend upon the energy derived from a sudden change in the velocity of the steam travel. For this reason there is no need of limiting the lift of the valve.

Efficiency of Incandescent Lamps.—In a paper read before the Société Française de Physique, M. G. Weissmann states that generally in incandescent electric lighting the efficiency obtained is much below the maximum which is possible with carbon filaments. This arises from the fact that the filaments are usually of very small diameter; and the smaller the diameter of the filament, the greater the watts per candle power required to insure a reasonable life to the lamp. In practice it is not possible, he states, to make a 110-volt lamp of less than five candle-power. Taking as a standard a 110-volt, 3½-watt, 16-c.p. lamp, then for other lamps at the same voltage and of equally long life the energy expenditure will be as follows:

Candle Power.	Watts per Candle Power.
5	5
10	4
32	3
50	2.5
100	1.8 to 2

With stout filaments, the surface from which disintegration can take place is small compared to the total value of the filament. It is possible, therefore, to raise the filament as a whole to a higher temperature without risk of breaking it, than is conveniently possible with fine filaments. The greater mass of the stout filament has a further advantage in producing a sort of "flywheel" effect, by which temperature changes due to instantaneous variations in the current are equalized. To improve the economy of low candle-power lamps, M. Weissmann introduces between the lamp and the switch a small transformer which lowers the voltage to, say, 22 volts, and thus makes it possible to use lamps of low resistance having thick filaments. With this voltage it is possible to work a 10-c.p. lamp satisfactorily at 2½ watts per candle, and it is even possible to use lamps of one candle-power. The transformers used by the author measure 4 ins. x 4 ins. x 2½ ins. and give an output of 30 up to 300 watts with efficiencies of 91 to 97 per cent, respectively. It should be noted that these transformers give no idle load, being switched out at the same time as the lamps themselves. The system has been in operation eight months, during which time some thousands of lamps have been installed.

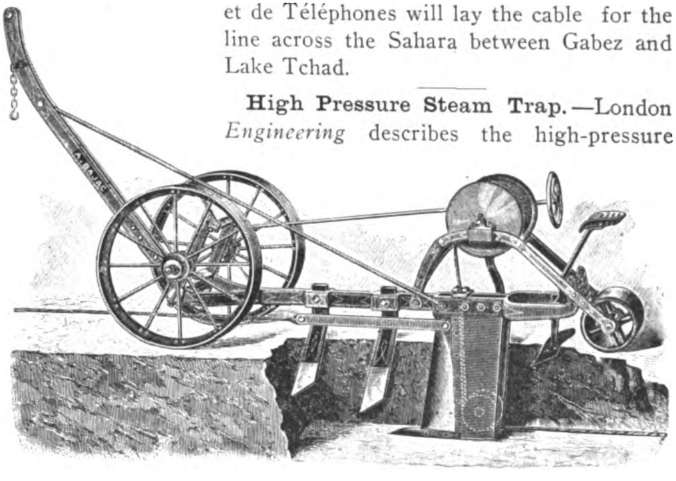
FIG 7.—CABLE TRENCH PLOW.

Plow for Laying Electric Cables.—Fig. 7, herewith, taken from a recent issue of *l'Industrie Electrique* shows an interesting labor-saving appliance which should be of use to power-distributing companies in country districts. It is intended to deposit in the ground at a depth of 28 to 32 ins., cables suitably insulated for light, power, telegraph and other purposes without digging a trench. The chief working part is a stout colter, which opens in the soil a vertical slot of the depth stated. The colter carries a conical plowshare at its lower end to give the necessary stability and cutting power; two small colters beginning the cutting in advance of the main colter. At the back of the latter are fixed two metal plates between which is carried, low down and at the rear, a grooved guide pulley for laying the cable. The latter is rolled up on a reel held above the body of the plow by a suitable frame, and as the plow advances is unrolled and deposited at the bottom of the channel prepared by the conical plowshare. A roller at the back of the apparatus smoothes over the earth behind the plow, and also serves to regulate the depth of the cable beneath the earth. The whole system is carried in front on two wheels mounted on slides which can be adjusted vertically, independent of one another, and which, together with the back wheel, determine the depth. It is interesting to note that this plow, which was constructed by M. Bajac for the Société Française de Télégraphes et de Téléphones will lay the cable for the line across the Sahara between Gabez and Lake Tchad.

High Pressure Steam Trap.—London *Engineering* describes the high-pressure steam trap shown by Fig. 8, herewith, and made by Holden & Brooke, of Manchester. As in many other traps of this kind, the expansion and contraction of a tube is utilized to open and close the valve through which the condensed water is discharged. In many cases the valve is closed directly by the expansion of the tube, but in the trap here illustrated the valve shown to the left is closed by the action of a spring and the pressure with which it bears on its seat is quite independent of the expansion of the tube forming the principal constituent of the device. Referring to the engraving, assume that the trap is cold, and owing to the pressure of the upper rod on the short arm of the bell-crank the valve is open. When steam is turned on it flows through the tube, *t*, and out of the open valve. When the the tube becomes hot its expansion relieves the pressure exerted on the bell-crank by the upper rod, and the valve is then closed by the spring. As condensation progresses, the tube becomes cool and contracts, opening the valve, through which the condensed water is expelled. The expansion and contraction of metals within such a range of temperature is necessarily small, and consequently it becomes necessary to magnify at the valve the motion of the free end of the rod. This is accomplished by the bell-crank which gives a multiplication of about 5 to 1, and this is further augmented by the plan of making the collar, *c*, against which the upper and lower rods bear, not solid with the tube, but pivoted about it on knife-edges as indicated. The two rods being at equal distances from the center line of the tube, this arrangement results in the motion of the short arm of the bell-crank being double what it would if the upper rod were solidly fixed to the tube at the right-hand end, and it will also be seen that this eliminates all bending strains on the tube. The trap is stated to open with a 5 per cent fall in temperature and may therefore be fitted directly to a steam pipe or cylinder.

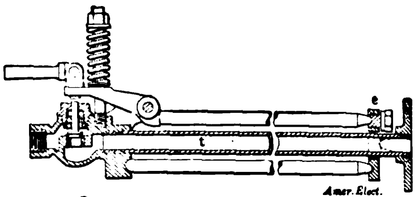

FIG. 8.—HIGH-PRESSURE STEAM TRAP.

Fuel Economy.—J. B. C. Kershaw, writing to the London *Engineer*, says that the steam boiler is not worked by the greater number of users so as to yield its highest possible efficiency. Instances might be given in which the actual steam-raising work of the boilers is only 50 per cent of that which could be obtained with the same boilers under more correct conditions of firing and draught. The remedy lies in the analysis of the fuel and the waste gases, whereby it is possible to tell exactly where the losses are incurred. The fuel used in all large generating plants ought to be adapted to the type of boiler installed, and a check should be kept upon the regularity of its thermal value and its ash contents as it is received in bulk from the mine. The waste gases passing from the boiler to the chimney ought also to be examined and tested at intervals in order to guard against the extremes of too little or too great a percentage of air being passed into the flues through the fire-box. Cases have occurred in which the steam raising efficiency of a battery of boilers was raised from 58 per cent to 70 per cent by this comparatively simple check upon the firing and the draught. With careful firing and a correct draught an average of 14 per cent of carbonic acid should be present in the chimney gases. The ordinary percentage is far below this figure, and some authorities place the figure as low as 8 per cent. This low percentage is due to excessive draught and consequent unnecessary amount of air passing through the boiler flues. The result is a large increase in the amount of heat carried away by the waste gases. The actual loss represented by the difference between 14 per cent and 8 per cent carbonic acid in the waste gases with the chimney gases at 560° C. is equal to 10 per cent of the fuel burned in the boilers.

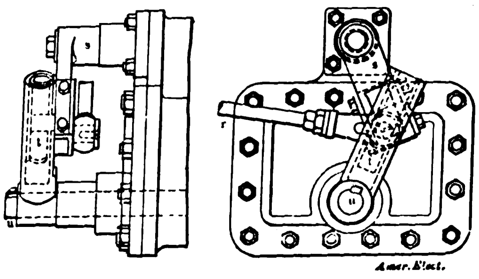

FIG. 9.

It is no doubt true that many engineers deliberately use excessive draught in their boilers in order to avoid the smoke prosecutions. It may be questioned, however, if many of these engineers have realized the money value of the fuel waste that occurs when excess of air is continually admitted into the fire-box; or given that recognition, whether they have known that it is possible both to avoid the smoke and save the 10 per cent (?) of the fuel by a more scientific management of their boilers.

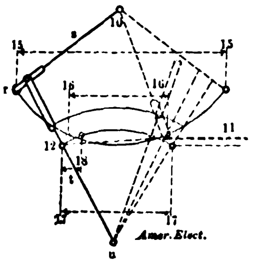

FIG. 11.

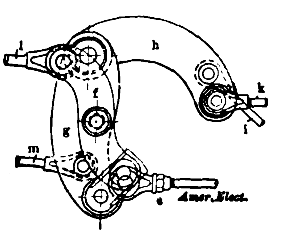

FIG. 12.

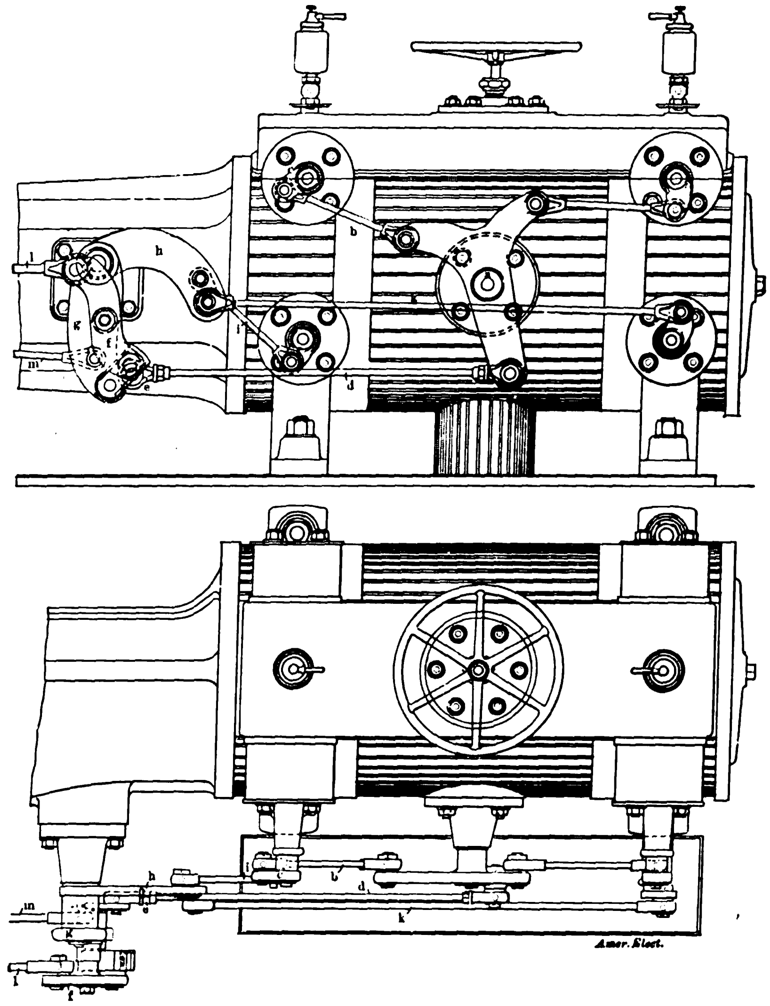

FIG. 13.—FOUR-VALVE BONJOUR GEAR.

Some European Corliss Gears.—A recent issue of the *Revue de Mécanique* contains a description of some of the Corliss gears used on the continent of Europe. One of the most interesting valve gears, it claims, is used on Bonjour's system and is characterized by the use of only one cylindrical valve for the distribution of steam. The motion of this valve is effected from the crankshaft by means of two eccentrics, and regulated by means of the rods, *e*, *f*, shown by Fig. 10. To the latter the two links, *a* and *b*, are coupled, of which *a* is connected by the shaft, *k*, to the slotted link, *l*, and by a prolongation below to the plunger of a small pump. The link, *l*, actuates the rod, *r*, which in its turn operates the valve.

The rod, *r*, is, however, not connected directly to the spindle of the valve, but, as shown in Figs. 10 and 9, two slotted links, *s*, and *t*, are inserted with, which the rod, *r*, engages through a common pin. The link, *l*, is mounted on a spindle, *u*, of the valve, and the link, *s*, on a stationary pivot fixed on the side of the cylinder jacket. This pivot is denoted by the number 10, in Fig. 11. The relative motion of the rod, *r*, the links, *s*, *t*, and the valve can be seen from Fig. 11. In this illustration the straight line, *15-15*, denotes the maximum travel of the rod, *r*; *16-16*, the maximum travel of the valve, and the distance, *18*, the maximum opening for the admission of steam. It will be seen, therefore, that the motion of the valve up to its mid-position is progressively retarded until the two links, *s* and *t*, are in a straight line. When this position is attained the

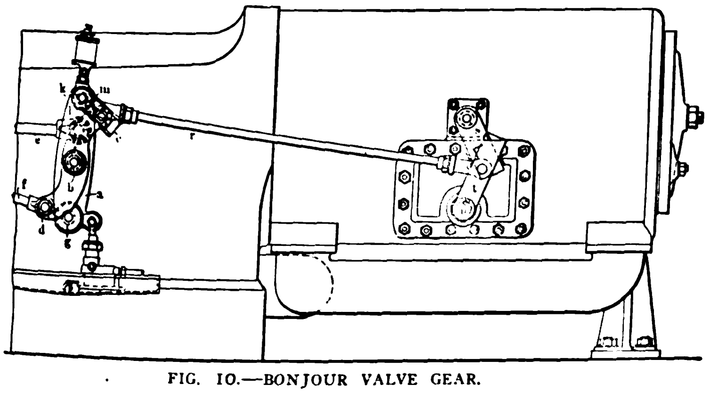

FIG. 10.—BONJOUR VALVE GEAR.

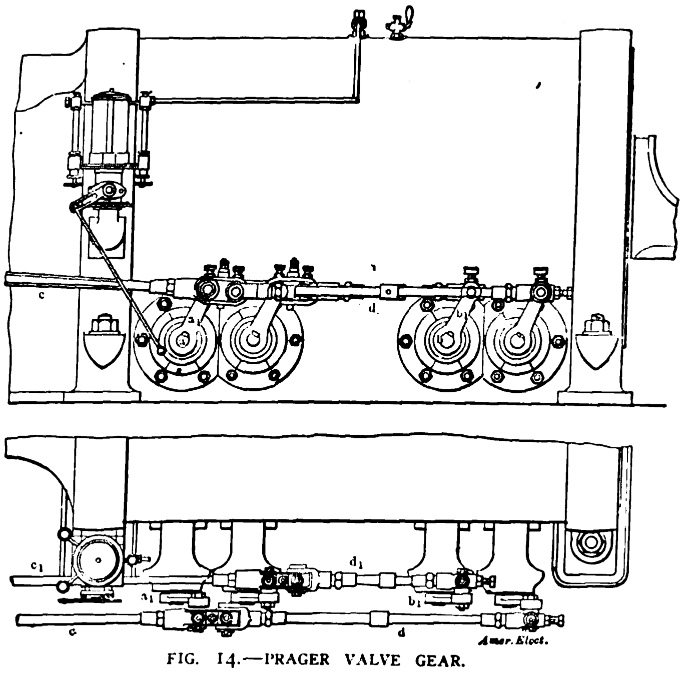

FIG. 14.—PRAGER VALVE GEAR.

arm, *t*, is held by a stop on the valve, which the arm, *s*, continues its travel.

The application of this gear to a cylinder with four Corliss valves is shown by Figs. 12 and 13. Of the four valves, the upper two serve for the admission, and the lower two for the exhaust of the steam, as usual. The admission valves are actuated from a T-shaped wrist-plate, pivoted as usual on the side of the cylinder. The wrist-plate receives its motion through the rod, *d*, of course, and the slotted link, *e*, from the pieces, *g* and *f*, which are themselves actuated by the rods, *l* and *m*, from two eccentrics on the crank-shaft. The exhaust valves are actuated independently of the steam valves from the curved lever, *h*, fulcrumed at the same center as the link, *g*.

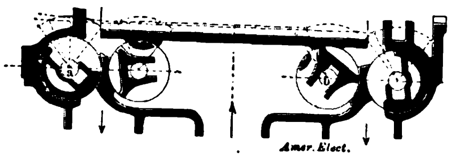

FIG. 15.—PRAGER VALVES.

Figs. 14 and 15 show a Corliss gear by the Prager Maschinenbau Gesellschaft applied to the low-pressure cylinder of a horizontal compound engine. All four valves are here placed under the cylinder and as near thereto as possible in order to minimize the clearance space. The two inner valves, *b*, serve for the admission of steam and the exterior valves, *a*, for the exhaust. The former receive the high-pressure steam from a central chamber, while the latter discharge the exhaust through two pipes into a common exhaust pipe. The valves are actuated by means of levers, *a*, *b*, and links, *d*, *d*, from the two eccentric rods, *c*, *c*. As the regulation of the admission valves by the governor is not required in this case, the valve gear becomes very simple.

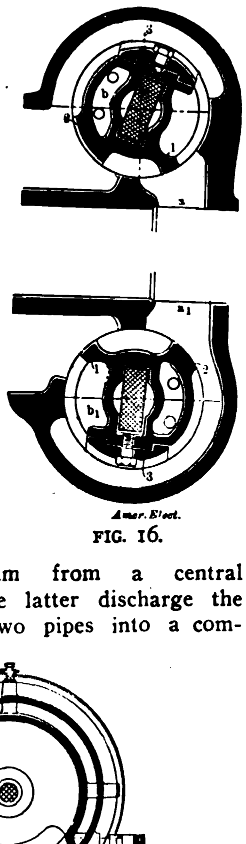

FIG. 16.

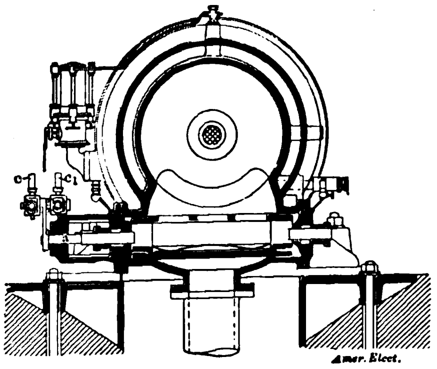

FIG. 17.—WANMICH ROCKING VALVE.

Figs. 16 and 17 give some constructional details of a positively-driven Corliss valve by Frederich Wanmich & Co., Bruenn, and applied to the low-pressure cylinder of a high-speed triple-expansion engine. The admission valves are of the section shown in the upper part of Fig. 16, and the exhaust has a section like that shown below it, the respective port openings being shown at *a* and *a*₁. The valve spindle is fixed to the valve body by means of springs (Fig. 17). The steam distribution can be varied by regulating the lengths of the eccentric rods operating the valves.

Some Recent Electrical Patents

Magnetic Clutch.—In almost every application of electromagnetic clutches it is essential that the clutch shall release as soon as the exciting circuit is opened. It is a matter of common experience, however, that clutches of this type are apt to stick after the exciting current is cut off, on account of the remanent magnetism. With a view to eliminating this disadvantage, Harold W. Buck uses a double winding on the clutch, the main exciting winding having the usual disposition. The second winding is connected up so as to oppose the main winding; its exciting force is proportioned so as to just neutralize the remanent magnetism that would otherwise exist when the main winding is cut off from the supply circuit. The auxiliary winding is left connected to the supply circuit at least long enough to insure the release of the clutch. Fig. 1 herewith illustrates the arrangement, in which the main coil is connected to the supply circuit through the switch, *S*, and the demagnetizing winding is connected to the lower supply circuit, *m* and *n*. Patent No. 701,290.

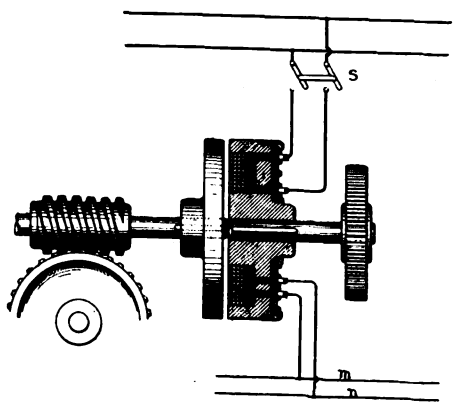

FIG. 1.—ELECTROMAGNETIC CLUTCH.

High-Voltage Insulator.—The essential features of a high-voltage insulator are, of course, that it shall have a high resistance from the exterior surface through the material to the pin or other support, that it shall also offer a high resistance to the leakage of current over the surface of the insulator, and that its shape shall be such that the distance from the supported wire to the insulator pin or other grounded structure shall be sufficient to prevent an arc from the wire to the pin. The first two requirements are readily fulfilled, and Fig. 2 herewith illustrates a method of fulfilling the third condition without resorting to an unwieldly size of insulator which has been devised by Vernon G. Converse. Mr. Converse's method consists of providing a series of air-gaps between prominent portions of the insulator which intervenes between the supported wire and the cross-arm, and shielding the lower part of the supporting pin by an insulating sleeve. The construction will be obvious from a glance at the illustration. The fundamentals of the insulator are the sleeves, *5*; the intermediate petticoat, *4*, and the cap, *3*. The inventor proposes to adapt the insulator to various potentials by interposing a larger or smaller number of petticoats, *4*, the higher the potential the greater the number of petticoats, of course. Patent No. 701,847.

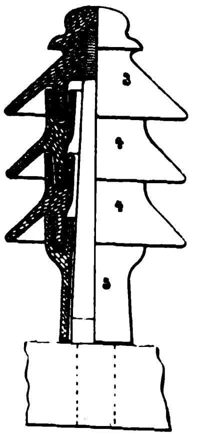

FIG. 2.

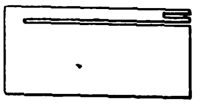

FIG. 3.

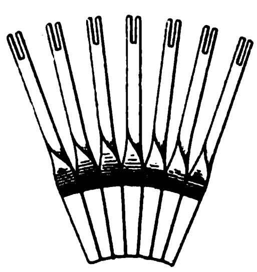

FIG. 6.

Commutator Segment. With a view to reducing the cost of commutator manufacture, Wm. H. Windle has devised the form of segment illustrated by Figs. 3, 4, 5 and 6, herewith. Each commutator segment is made from a simple rectangular piece of copper, which is slitted as shown in Fig. 3. The narrow strip left at the top by the long slit is then bent upward, as shown in Fig. 4, forming the lug for receiving the armature leads. The slot, *5*, being in the wrong plane, the lug is given a quarter twist, leaving the segment as shown in Fig. 5. Fig. 6 illustrates a section of a commutator made up of segments of this character. Patent No. 702,272.

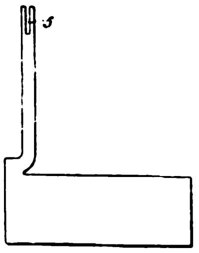

FIG. 4.

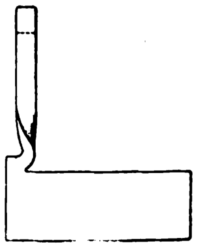

FIG. 5.

NOTES.

New York Electrical Society.—At the annual meeting of this society, which was held recently, the following officials were elected: President, Dr. Samuel Sheldon; vice-presidents, H. A. Lardner, Geo. H. Condict, H. V. A. Parsell, W. I. Donshea, Hobart D. Betts and W. S. Barstow; secretary, Geo. H. Guy; treasurer, H. A. Sinclair.

A 100,000-H. P. Central Station for Chicago.—It is reported that the Commonwealth Electric Company has purchased 616,000 square feet of land fronting on the south branch of the Chicago River for the purpose of erecting what will ultimately be one of the largest central station plants in the world, having a capacity of 100,000 horse-power. The station equipment will probably be three-phase alternating current machinery.

Science Abstracts.—We are advised by the editor of this well-known publication that the list of periodicals regularly covered in *Science Abstracts* has been augmented by the following: Journal of the Russian Physico-Chemical Society (Russian); Proceedings of Academy of Sciences, Amsterdam (Dutch); Proceedings of Academy of Sciences, Stockholm (Swedish); Proceedings of Academy of Sciences, Christiania (Norwegian); Proceedings of Academy of Sciences, Copenhagen (Danish); *Zeitschrift für Anorganischen Chemie;* Royal Society of Edinburgh Transactions and Proceedings; British Optical Journal; *Electtricista* (Rome); Iron and Steel Institute Transactions; American Society of Mechanical Engineers Transactions; *Engineering and Mining Journal* (New York); *Power* (New York); *La France Automobile; Der Motorwagen; Automobile Review* (Chicago); Archives of the Röntgen Ray, and the Bulletin of the Philosophical Society of Washington. This list brings the total number of periodicals from which abstracts are taken up to about 150.

The Coming World's Fair at St. Louis.—The officials of the Louisiana Purchase Exposition, to be held at St. Louis in 1904, will depart radically from the usual policy observed in connection with such affairs, in that no charge will be made for exhibit space nor for power, light and such facilities as may seem reasonably necessary for the best presentation and operation of a desirable exhibit. This policy, judiciously administered, and coupled with the further fact that the financial resources of the exposition are far and away above those which have been at the disposal of any other enterprise of this character, should insure overwhelming success, so far as the exhibits are concerned. The United States Government has appropriated $5,000,000 toward the expenses of the exposition, independent of any appropriation that may be made for the Government building or to cover Government exhibits. This appropriation was made by Congress only after the exposition company had raised $10,000,000 for inaugurating and carrying forward the exposition, and the total available resources of the enterprise are said to be many times greater than the aggregate of the sums mentioned. Blank forms of application for space may be had now, on request, from F. J. V. Skiff, director of exhibits.

Production of Aluminum.—The production of aluminum in the United States during 1901 amounted to 7,150,000 pounds, according to a recent bulletin issued by theh United States Geological Survey. The bulletin states that the Pittsburg Reduction Company remains the sole producer of aluminum in this country. The price of aluminum remained practically stationary throughout the year, although the demand for the metal increased.

Engine Builders' Convention.—At the fourth semi-annual meeting of the Engine Builders' Association of the United States, held recently at Pittsburg, Pa., several extremely interesting papers were read. The titles and authors were: "Engine Forgings," by H. F. J. Porter, of the Bethlehem Steel Company; "Engine Requirements for the Parallel Operation of Alternators," by Mr. E. M. Tingley, of Pittsburg, Pa.; "The Requirements for the Paralleling of Alternators as Viewed by Engine Builders," by H. M. Longwell, of Pittsburg, and "Piping Materials for Steam Plants," by Mr. John B. Berryman, of Chicago. Abstracts of those papers which come properly within the scope of the AMERICAN ELECTRICIAN are given elsewhere in this number. The convention was attended by about 25 members and visitors, who made use of their opportunity to visit the extensive works of the Westinghouse Machine Company and the Westinghouse Electric & Manufacturing Company at East Pittsburg.

National Electric Contractors' Association.—The annual convention of the National Electrical Contractors' Association of the United States will be held in Philadelphia, July 16 and 17. The board of directors will meet at the hall of the Franklin Institute, No. 15 South Seventh street, at 9 o'clock on the morning of July 16, and the first meeting of delegates will be held in the same hall at 1:30 in the afternoon. At 4:30 on the same afternoon a special boat will leave Arch Street wharf and take delegates and invited guests along the river front to Cramp's shipyard and League Island; on the return the boat will land at Washington Park at 6:30. The session on the next day will be held on the Steel Pier at Atlantic City, at 3 o'clock. A special train will leave Philadelphia for Atlantic City at 9 o'clock on the morning of July 17. The entertainment committee will provide transportation to and from Atlantic City for the delegates, and the tickets will allow the holders to return at any time within six days, so that those wishing to remain in Atlantic City for that period may do so.

Canadian Electrical Association.—This association held its twelfth annual convention at the city of Quebec, Canada, June 11 to 13, inclusive. A number of interesting papers were read, among them one by Mr. W. D'A. Ryan, of Lynn, Mass., on "The Development of Arc Lighting Apparatus;" one by Mr. C. M. Greene, of Lynn., Mass., on "Arc Lighting;" one by Mr. Percy H. Thomas, of Pittsburg, Pa., on "Lightning Protection and the Static Interrupter," and one by Mr. A. A. Dion, of Ottawa, Can., on "The Use of Storage Batteries in Electric Distribution Systems." Mr. Ryan's paper was somewhat historical, but closed with some practical deductions which may be summarized as follows: For a given wattage open arcs give a higher maximum candle-power than enclosed arcs, but this maximum is in an undesirable direction, and the light fluctuates through wide limits; enclosed arcs give a higher candle-power through the most useful angles and a steadier and more uniform light than open arcs; direct-current and alternating-current enclosed arcs are practically equal in merit, so far as illuminating value is concerned, though the direct-current lamp gives a slightly higher candle-power for given input in watts; both are superior to the direct-current open arc. Opal inner globes and clear outer globes will illuminate a greater area than any other combination. Mr. Greene's paper consisted largely of a classification of arc lamps, supply systems and generators. The conclusions deduced were that the direct-current enclosed-arc system is the best and most economical for plants devoted exclusively to arc lighting. The series alternating-current enclosed-arc system supplied from a constant potential source is the best for plants using large generators of 40 to 125 cycles frequency, where the arc-lamp load is a small part of the total load, and the enclosed-arc lamp is better and cheaper to operate than the open arc. Mr. Thomas' paper was extremely interesting and instructive and cannot be abstracted with justice to the author. Mr. Dion's paper dealt with the development of the modern storage battery and pointed out the conditions under which its application is advantageous. The officers elected for the ensuing year are as follows: President, B. F. Reesor, of Lindsay; first vice-president, Edward Slade, of Quebec; second vice-president, K. B. Thornton, of Montreal; secretary-treasurer, (re-elected), C. H. Mortimer, of Toronto; executive committee (five members re-elected): J. J. Wright, Tronoto; A. A. Dion, Ottawa; John Yule, Guelph; O. Higman, Ottawa, and A. Sangster, Sherbrooks, Quebec. (Five new members elected), P. G. Gossler, Montreal; E. A. Evans, Quebec; A. B. Smith, Toronto; A. A. Wright, Renfrew, and G. Henderson, Hamilton. Committee to confer with underwriters: Messrs. P. G. Gossler, Edward Slade, A. D. Dion, Alderman Sadler (Montreal), A. Sangster and J. J. Wright.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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The Electric Light Convention.

The recent convention of the National Electric Light Association was remarkable for both the quantity of work done and the quality of the papers read. The number of papers was the largest that has ever been read at any convention in the history of the association, and contrary to the usual result of plenitude, the average merit was high. A most valuable feature was introduced at this convention, namely, a "question box." Questions were sent in on numerous practical subjects by a large number of members, and replies to these were given by others whose experience enabled them to do so. We shall publish some of these questions and replies each month hereafter until all that are of general value have been presented. It is to be hoped that this will be made a permanent feature of the association's meetings.

In the proceedings, which we print at considerable length this month, will be found many intensely practical and sensible discussions. Among these may be noted the remarks of Mr. F. W. Willcox on the subject of the best incandescent lamp efficiency. With characteristic thoroughness and analytical acumen, Mr. Willcox refrained from speculative generalizations and resolved the question into one of simple arithmetic. The essentials of his analysis are given on another page, and will be found of much interest. The only variable assumptions that were made were the prices of incandescent lamps, and it would be a simple matter to substitute any other prices and, by following Mr. Willcox's method, deduce a table or chart showing precisely the best efficiency to be used. Of course, the whole argument is based on fair regulation, without which a representative performance by high-efficiency lamps cannot be expected.

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Polyphase Distribution.

The question of preference between two phases and three phases for distribution purposes is one that has never been discussed exhaustively, and has been a source of much perplexity to managers and engineers of moderate-sized alternating-current central stations. We confess to considerable disappointment, therefore, upon perusal of the papers that were read by Messrs. Scott and Behrend on this subject at the recent electric light convention, in view of the need for a thorough discussion of the question and the conspicuous ability of these two gentlemen to supply it. Both papers were of much general interest and value to those unfamiliar with the characteristics of alternating-current apparatus, but neither of them shed great light upon the question of making a choice between the two chief polyphase systems for distribution circuits. Mr. Behrend called attention to the facts that, owing to reactions in the generator, the two-phase system is not so greatly superior to the three-phase system in point of inductive interference between the phases as might be supposed, but the two-phase machine has better inherent regulation than the three-phase generator. Concerning distribution, he said there is not much choice between the two systems, although the three-phase possesses "certain slight advantages."

The question of regulation, while it has an indirect bearing on the choice of phases for distribution purposes, is not the sole criterion, nor is it even the chief factor in the problem, since it is easy to transmit one number of phases and distribute the other. It appears to us that Mr. Behrend was unduly conservative in his reference to the four-wire three-phase system, which has the independence and superior regulation that characterize the two-phase system, together with higher copper economy and the advantage of two efficient working voltages without transformation. The e. m. f. between each pair of main wires being 1.73 times that between each main wire and the neutral, as is well known, a lighting load may be served at about 115-116 volts and a motor load at 200 volts (or 230 and 400 respectively) without using different kinds of transformers for the two; that is to say, all of the transformers used about the plant may have the same ratio of transformation. The value of this feature will depend, of course, on local practice in the use of transformers, but it would ordinarily be advantageous. The saving in copper, however, is probably the chief advantage of the three-phase system, and this saving is by no means negligible in mains and feeders. It is entirely feasible to operate four-wire three-phase primaries in a moderate-sized plant at approximately 1155 volts between the neutral and each outer wire, and 2000 volts between outer wires with 85 per cent. of the copper required for four-wire two-phase primaries of the same voltage per phase (2000).

As pointed out by Mr. Lincoln, in the discussion at the convention, it is essential that two-phase circuits be pretty well balanced when motors are operated, because the motors tend to rectify the unbalancing by transferring energy from the lightly-loaded to the heavily-loaded side, at risk to their windings. This is, of course, also true of the four-wire three-phase system; in fact, the two have precisely the same general characteristics, except the higher economy in copper and the double voltage of the four-wire three-phase circuit. The only point of advantage possessed by the two-phase system is that motors require two transformers each, while three-phase motors require (under American practice) three transformers each, the latter transformers being, of course, two-thirds the size of the former.

The American Institute Annual Meeting.

The recent annual meeting of the American Institute of Electrical Engineers, like the electric light convention, was remarkable for the excellent quality of the papers that were read, many of which we are able to give in abstract this month. Owing to the lateness of the meeting, together with the unusual number of convention reports to be handled, it is unfortunately impracticable to cover the Institute meeting in full. An unusually large proportion of the papers presented at this convention were of a highly practical character, applicable to the everyday purposes of the central station man. Notable in this class were the papers by Messrs. Arnold, Arnold and Potter, Baum, Mailloux and Thomas. The others, almost without exception, were extremely valuable also, but they were of a more mathematical character and of interest rather to the student and designer.

Mr. Mailloux's description of experiments made with two single-phase alternators and a rotary converter, on a two-phase circuit, was one of the most interesting contributions to alternating-current working that has been presented for many a day. It may not become common practice to supply a two-phase load from two single-phase alternators, kept in proper phase relation by means of a rotary converter, but the fact that it positively can be done is well worth knowing, and that is what Mr. Mailloux's experiments demonstrated. Prof. Baum's method of compounding generator fields is doubtless of high utility. Everyone is familiar with the difficulty of compounding an alternator supplying an inductive load (and very, very few supply the other kind) so as to discriminate between the armature reaction due to non-lagging current and the greater reaction exerted by lagging or leading current in the armature; and it is also a matter of common knowledge that the individual compounding of direct-current generators operated in multiple is not adjustable with the ordinary arrangement of windings. Prof. Baum's methods supply relief for both of these drawbacks; the method of compounding alternator fields compensates for the increased reaction due to phase displacement of the armature current, and the system of direct-current compounding enables one to make any distribution of load among two or more dynamos that one chooses. Space limitations prevent the extended reference to the various papers that their merit warrants, but we strongly commend them to the careful attention of everyone interested in electric power generation and supply.

Rates for Electric Service.

The problem of devising a method of charging for electric light and power service which will be equitable and satisfactory to the consumer and producer alike is one of the most difficult that has ever arisen in the business department of the central station industry. The farther away one gets from the ancient fallacy of flat rates for unlimited service, the harder it is to satisfy the consumer; on the other hand, according to the views of many of the more experienced and analytical station men, the more complex the system of charging, the better it is for the central station and the more equitable all around. We strongly incline to the opinion that the latter is almost as far wrong as the flat rate delusion.

Charging a consumer for "readiness to serve," or make any other fixed charge to compensate the central station for providing (as distinguished from operating) a plant is almost as irrational as it would be for a drygoods store to charge its regular patrons an admission fee. Of course, individual transformers, meters, feeders heavier than required for normal service, or any other part of the equipment devoted solely to the convenience of any one consumer or group of consumers, should be made the basis of a fixed charge, and no right-minded consumer would object to such a charge. But the idea of making a fixed charge to cover the station capacity that is at a consumer's disposal is wholly inequitable and illogical. There should be no difficulty in supplying current at a meter rate that will give returns on the station and mains investment and still be reasonable to the consumer. Differential rates are a good means of reducing the irregularity of the load curve, and are perfectly fair to all classes of consumers; and it would seem that such rates, combined with a fixed charge to pay for the abnormal idleness of exclusively individual equipment, constitute practically the limit of equitable elaboration in the matter of service charges.

The Independent Telephone Association.

The convention of the Independent Telephone Association of the United States, held recently at Philadelphia, was as conspicuously lacking in actual work and meritorious papers as the electric light convention was notable for these characteristics. In three days' time only five papers were read, and there was no considerable amount of discussion. Partly on this account, but chiefly, we are convinced, on account of the lack of variety in the papers, only the first session was well attended. In a spirit of friendliness we suggest that a radical departure from the methods of this last convention is essential to the welfare of the association. The burden of all the papers, save one, was criticism (frequently vituperative) directed at the Bell Company and a possibly premature rejoicing, not over independent success *per se*, but over the "routing of the enemy," wherever victory has been achieved.

It is but natural to feel elated over a successful contest with a powerful opponent, and it is encouraging to others in the same line of work to relate progress and prosperity, but no industry can thrive on nourishment consisting solely of hysterical denunciation of self-congratulation. As Mr. Stanton intimated in his excellent paper, the success of the independent telephone industry demands a careful consideration of engineering problems, comparisons of operating methods, standardization of equipment and dozens of other factors which were not even mentioned at the convention. Judge Thomas, in his annual address, also indicated requisites to success which have been thus far neglected.

The struggle for a footing having been successful, future development is a question almost solely of engineering and operation, into which sentiment enters but slightly, if at all, and upon which the Bell Company's method of opposition have no general bearing whatever. The sooner the telephone association recognizes the many vital factors of telephone engineering, and ceases to devote time to obsolete issues and utopian predictions, the sooner will it wield a salutory influence toward placing the industry on a sound and permanent commercial basis.

CONSTRUCTION OF WIRELESS TELEGRAPH APPARATUS.

BY WM. A. DEL MAR.

THE SUBORDINATE TRANSMITTING APPARATUS.

In wireless telegraphy more than in most other kinds of work, good results can only be expected when the utmost care is taken to make every detail of the installation as perfect as possible. A bad contact or a faulty insulation may stop the entire action, while defective instruments are generally as useless as none at all. If, however, the work be done with care, the results are so startling as to amply repay one for the trouble taken. Some details of the transmittting apparatus are given here, which are usually omitted in descriptions of this work, but which go a long way towards the attainment of success.

The transmitting arrangements are very simple. There is an induction coil capable of giving a spark from six to ten inches long, but the spark gap is adjusted to one-quarter or three-eighths of an inch. This coil derives its energy from a battery of dry cells, or better still, storage cells. In series with the battery and primary of the induction coil, is a key by means of which the current can be broken into the required succession of impulses according to the Morse code. The connections are shown complete in Fig. 1.

Each time the key is depressed, the vibrator of the induction coil is set in operation and there is a train of sparks between the knobs of the spark gap. These knobs are solid brass balls of about one inch diameter. One of the balls is grounded, as shown in Fig. 1 and in the manner described below, and the other is connected to a tall conductor supported on a mast or on the side of a house. A 10-inch spark coil will do for signalling at least 20 miles, but for shorter distances a smaller coil may, of course, be used. In any case the spark actually used must be much smalller than the maximum spark that the induction coil will give.

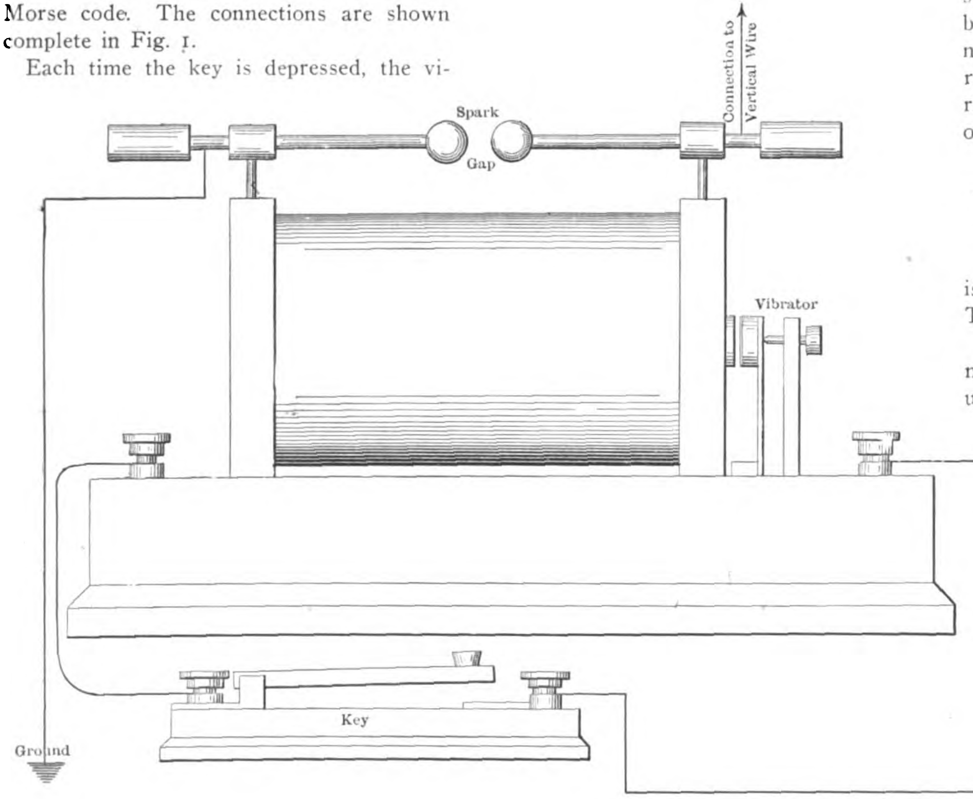

FIG. 1.—ELEVATION AND CONNECTIONS OF WIRELESS TELEGRAPH TRANSMITTING APPARATUS.

The height of the vertical wire required for signalling to a given distance depends very much upon the quality of the apparatus employed, so that it is impossible to predetermine it for unknown instruments. The curve in Fig. 2 gives the approximate figures obtained with instruments like those used by Marconi a few years ago in his early experiments in England. They do not even approximate to the results obtained in his later work, owing to the employment of vastly improved apparatus, but will be useful to those who are beginning this line of work. With any given set of instruments, however, the distance that can be signalled over is proportional roughly to the square of the height of the aerial conductor. For example, if with a conductor 40 ft. high it is possible to signal four miles, with one 80 ft. high it will be possible to signal 16 miles. As a matter of fact, this law is not quite accurate and the error is in favor of the distance that can be bridged; for example, a conductor 80 ft. high should be good for signalling 18 miles.

The conductor itself consists of a stranded cable of about No. 7-20 size, insulated with rubber and tape. It is attached to the mast at distances of about 6 ft. by means of porcelain insulators such as are used to support the conductors of high-tension transmission lines. These insulators should carry the conductor at least 6 ins. from the wood or brickwork. When it is carried from the mast to the instruments the aerial conductor is similarly insulated, especial care being taken where it is brought through the wall or ceiling into the room.

The conductor may be tested for insulation in the following way: The sparking terminals of the induction coil are separated so that no spark can pass and one of them is connected to a water pipe or other good "ground." The end of the vertical wire is then gradually brought near the other terminal of the coil. If there is any appreciable sparking between the vertical wire and the ball, the insulation is defective and must be overhauled. This is a very important point and must not be neglected.

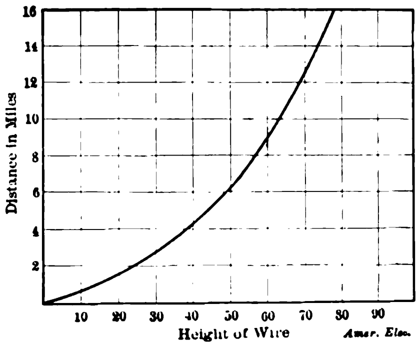

FIG. 2.—CURVE FOR HEIGHT.

The mast should be a wooden one, but it may be stayed with the usual galvanized-iron wire if there be a loop of hemp, such as that shown in Fig. 3, to insulate each stay from the ground. These loops should be well tarred or waxed, so that they will not become conducting when subjected to rain. Instead of a loop of rope, an iron ring covered with tarred rope may be used, or a double porcelain-knob "break," such as is used in electric light and railroad plants. These insulators should be near the ground.

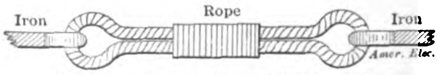

FIG. 3.—HEMP INSULATING LOOP.

If it is impossible to provide a very tall mast, a number of shorter ones may be used, the lower ends of all the conductors being connected together. The method of erecting a mast depends entirely upon local conditions. It may be fastened to the roof or side of the house or it may be set in the ground. In the former case, the best way is to erect a wooden frame on the roof and put a conductor on each of the vertical poles. These conductors may be joined together on the roof and one cable continued over the side of the house down to the room where the instruments are. Such a framework is shown in Fig. 4 without the conductors and insulators. The uprights are set in holes about a foot deep, drilled in the brick and are stayed together by wooden rods and to the brickwork by galvanized-iron wires. It is sometimes advantageous to put a capacity or condensance on top of each vertical conductor. This usually takes the form of a zinc cylinder about one foot in diameter soldered to the wire.

Where the mast has to be erected on rocky soil, a hole must be blasted out to a depth of one-sixth of the length of the mast and the mast set in with concrete or cement. In a clayey soil or gravel, a role should be dug to a depth of about one-fifth of the length of the mast, and in replacing the soil it must be thoroughly rammed at every stage. In either of these cases, the stay wires are fastened to large stones buried in the ground.

Large masts are usually made in several sections fastened together as shown in Fig. 5, by means of iron hoops and angles. A tree may be used to carry the aerial conductor if all the branches and leaves that would interfere be removed.

The vertical conductor at each station acts by turns as receiver and transmitter. In order to enable it to fulfill these two functions a switch should be provided to enable the conductor to be connected either to the transmitting or to the receiving apparatus alone. A switch designed for this purpose is shown in Fig. 6. The bottom of the aerial conductor is connected to an iron lever near each end of which is a small horse-shoe magnet. When the cord *B* is pulled, the long arm of the lever falls and the magnet makes contact with and adheres to the iron plate, *T*, connected to the induction coil. When the cord, *A*, is pulled, the magnet, *N*, is drawn into contact with and adheres to the iron block, *R*, which is electrically connected to the receiving apparatus. The distance between *M* and *T* when *N* touches *R* must be slightly greater than the maximum spark length of the coil.

The switch is put high on the wall with the cords *A* and *B* hanging from it in order to obviate danger from shock. The pivot of the lever is not attached to the wall or boards. It consists of an iron bolt soldered onto the copper conductor on top of the lowest porcelain insulator. The lever is connected electrically to the aerial conductor by means of a bit of insulated flexible wire soldered to both. The details of the pivot and connections are given in Figs. 7 and 8. The dimensions of some parts of

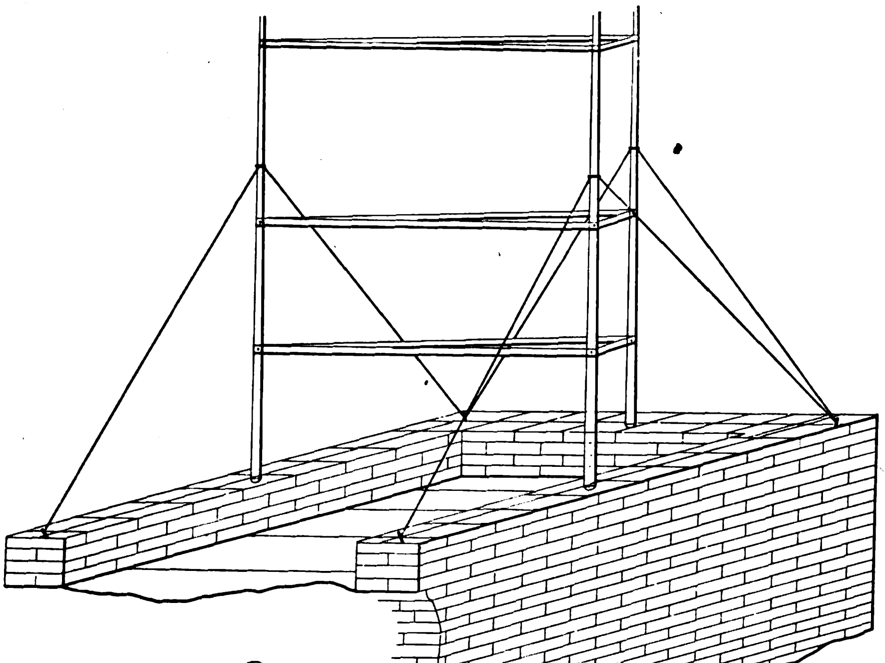

FIG. 4.—MULTIPLE MASTS.

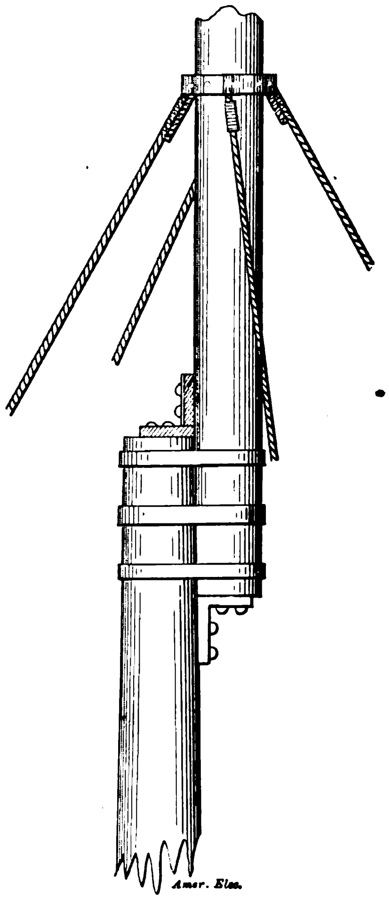

FIG. 5.—SPLICED MAST.

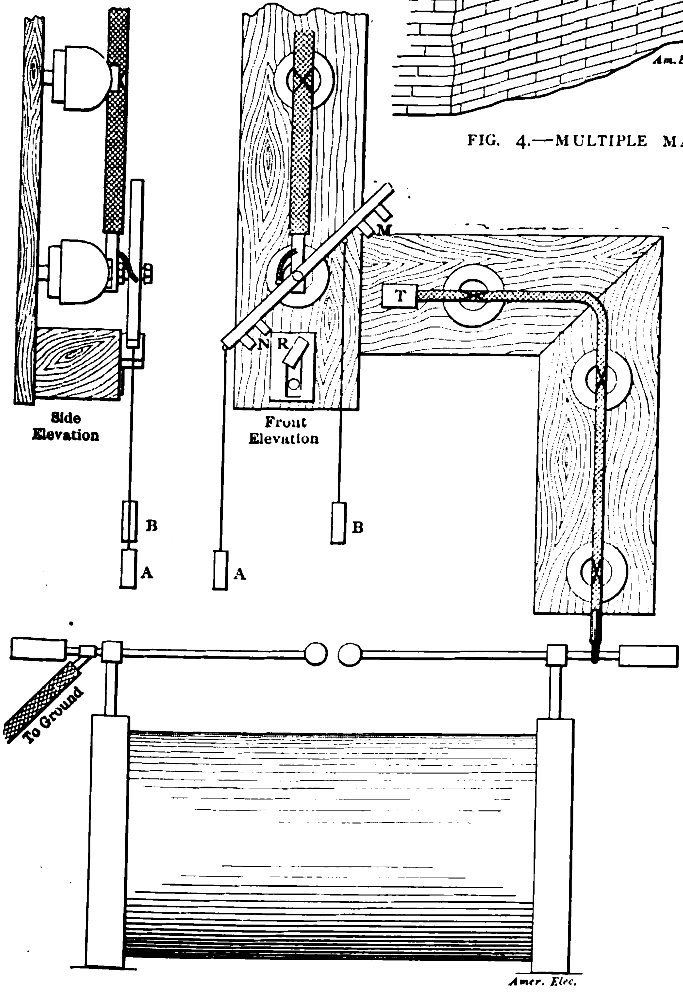

FIG. 6.—SWITCH AND CONNECTIONS.

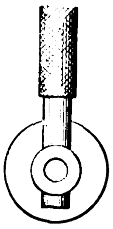

FIG. 7.

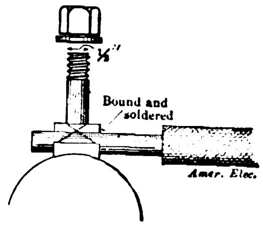

FIG. 8.

this switch depend somewhat on local conditions, but a length of 15 ins. is about right for the lever.

This is shown in detail in Fig. 9. It consists of two strips of iron with the magnets clasped between them, the strips being held together by long screws. The block *R*, which is shown in detail in Fig. 10, rests on a large wooden block which is screwed onto the wiring board from behind.

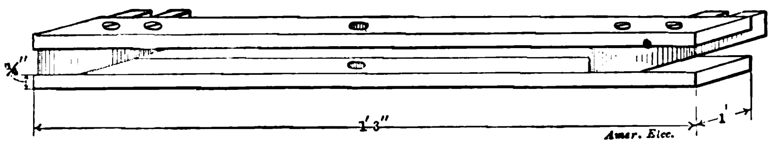

FIG. 9.—LEVER AND MAGNETS.

The height of this block depends on the height of the insulator, and must be such that the block, *R*, is in line with the lever and magnet. The wiring boards should be of 1-in. pine, about 8 ins. wide, planed, and varnished with shellac. The insulators are preferably bolted on from behind, the nuts being countersunk in the wood. The block, *T*, should be a plain rectangular one about 2 ins. x 1 in. x width of magnet. A hole is bored in it to fit the wire from the coil and the latter soldered in it.

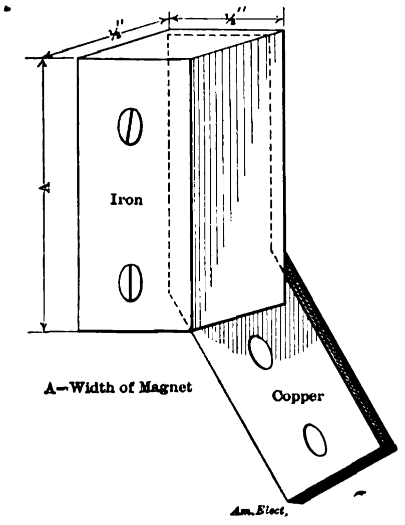

FIG. 10.—DETAIL OF CONTACT BLOCK.

The best "ground" for wireless telegraph purposes is undoubtedly a water pipe, but if this is not available a sackful of coke may be buried in the ground at a depth where there is appreciable permanent moisture, and a plate of iron or preferably copper set in this. This plate is then connected to the instruments by an uninsulated iron wire.

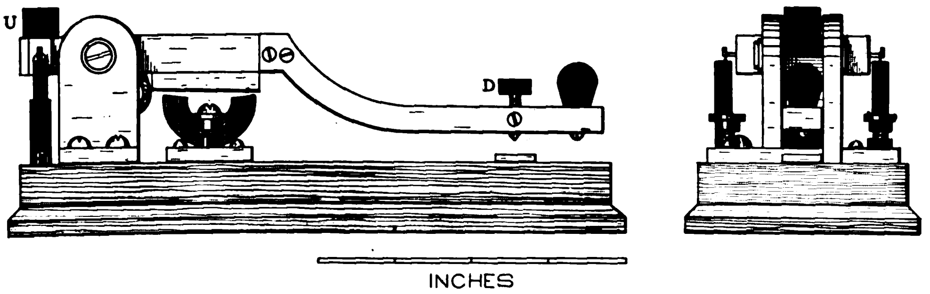

FIG. 11.—SIDE AND END ELEVATION OF TRANSMITTING KEY.

The rather large currents taken by the induction coils used in this work are with difficulty broken into the required succession of impulses, on account of the rapid deterioration of the contacts of the key. It is hence essential that the key be provided with ample conducting surface where the current is broken, and in order to secure satisfactory operation there should be little or no friction between these surfaces. A key with a mercury contact is very satisfactory for many purposes, but is lacking in portability. The key here described was designed to be portable and yet have the advantage of large contact surface with little friction.

The essential part is a bundle of copper strips bent into a semi-circular shape, as shown in Fig. 11, and arranged so as to make contact at the ends with a flat plate of copper on the lever of the transmitting key. Similar contacts are used in the automatic circuit-breakers of several of the manufacturers. The elastic bunch of copper strips is screwed to a brass plate which is provided with a binding post, and this is screwed onto the wooden base. The flat copper plate which makes contact with the edges of the strips is secured by means of countersunk screws to a long lever, which with its supports forms the most conspicuous part of the key.

The lever is normally held up, so that the contacts are kept apart, by means of a pair of coil springs at the rear end of the key, and it is prevented from rising too high by means of an ebonite headed screw, *U*, situated between the springs. The downward motion of the lever is limited by means of a similar screw, *D*, at the front end. The two supports at the fulcrum are, like the lever itself, made of brass and are screwed to the wooden base. One of these supports is provided with a binding post and is connected electrically to the lever by means of a short piece of insulated flexible wire capable of carrying at least 10 amperes. This wire is soldered to the under part of the lever and the inner side of the support.

As the outer strips of the elastic bundle are more readily pressed out than the inner ones, they are made somewhat longer than the latter, so that the bundle is of the form shown in the engraving. The inner strip forms somewhat less than a semi-circle, so that when pressed it spreads outward, while the outer one is almost a complete semi-circle. The strips are soldered together for about ¼-inch on each side of the screw. The face of the copper contact plate is inclined so that when the lever is depressed it will make contact with both ends of the curved strips simultaneously. In order to secure good insulation the copper or brass plate supporting the semi-circular bundle should be as far as possible from the supports of the lever.

The bunch of copper strips is best obtained ready made from a manufacturer of circuit breakers.

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EMERGENCIES IN THE BOILER ROOM.

BY R. A. DOUGLAS.

One of the commonest emergencies in the boiler room consists in the breaking of the gauge glass. Every engineer has been through this rather trying experience, and knows that it is by no means a comfortable matter to shut the valves leading to the glass. The lower valve, through which water is passing, should be closed first in all cases, because it is a trying matter to close the steam valve above, with hot water blowing up under the full boiler pressure. It is easy, however, to wrap a piece of sacking, or any convenient material of that nature, about the hand, and close the lower valve. When this has been effected it is a simple matter to close the upper one. The amount of water in the boiler must then be determined by the try-cocks alone, until the engineer finds it convenient to replace the broken glass. Spare glasses should always be kept on hand to provide against emergencies of this sort, but it is a common experience to find these spare glasses broken from some mysterious cause when they are wanted. Spontaneous breakage of this kind is almost invariably due to the glasses having been injured on their inner surfaces, before being put away. Comparatively few engineers realize how sensitive a gauge glass is to such internal injuries. Many keep their spare glasses strung upon a wire, the wire being hung upon a nail somewhere out of harm's way. When this method of preserving them is adopted, nothing harder than a copper wire should be used. Glasses that are strung upon an iron or steel wire are very apt to break subsequently and apparently without cause, from the effects of the slight friction of the iron wire against their inner surfaces as they are strung upon it. The experiment has been tried many times of rubbing the inner surface of a gauge glass slightly with the end of an iron wire. The glass seldom breaks immediately, but however carefully it is put away, even when wrapped in cotton and placed in a receptacle where the temperature will be quite uniform, it is likely to break spontaneously in the course of time. This fact, which is abundantly established by repeated trials, will hardly be believed by those who have not made the experiment themselves.

An emergency of far more serious character consists in the unexpected discovery that the pressure in the boiler is much higher than it was supposed to be. For some reason (or more likely for no reason at all), the steam gauges and water-glasses in boiler plants are very often so poorly situated and so badly lighted that they can hardly be read from the boiler-room floor. Sometimes an electric light or a gas jet is provided to make them more legible, but too often nothing of the sort is found, and the steam gauge can scarcely be read, even when it is new. In such cases a little age and neglect, with the accompanying dust and the webs of industrious spiders, soon render it very easy for the attendant to make a mistake.

Even when the gauge is properly illuminated and properly cared for, an unexpected and dangerous increase of pressure sometimes occurs from one cause or another. This may happen when the boiler is being driven hard, and the load suddenly thrown off so that the draft of steam is practically stopped. A watchful attendant should not be caught napping in this way; but the regular routine of his duties may have been going along so smoothly for days and perhaps for weeks, that he may not observe the changed state of affairs until the pressure has run up considerably. Of course it is easy to say that such a condition of affairs is improbable, because the damper regulator would cut off the draft, and the boiler would relieve itself through the safety valve. The fact remains, however, that the thing does actually happen from time to time, the damper regulator being absent or inoperative, and the safety valve stuck fast.

Generally speaking, excessive pressure is not as likely to occur in a battery of boilers, where there is a safety valve to every boiler, as it is in a single, isolated boiler; but under certain circumstances the reverse is true, and over pressure is more likely to occur in a battery than in a single, detached boiler. For example, let us suppose that one boiler in a battery has been shut down for cleaning or repairs. When it is desired to put this boiler into service again, it is filled and a fire is started under it. After awhile the pressure begins to show on its gauge, and after this it is the business of the attendant to watch the gauge closely, and to open the stop valve on this boiler when the pressure becomes precisely equal to the pressure on the rest of the battery. And here it may be well to say that the stop valve on a boiler that is about to be connected with other boilers in this manner should be opened slowly and with extreme caution. It is practically impossible to ensure *exact* equality of pressure between the newly-fired boiler and the rest of the battery, and any small difference of pressure that may exist should be allowed to adjust itself very slowly.

Now it sometimes happens that the attendant omits to open the stop valve on the boiler that he is putting into service, and in this case there are large possibilities of trouble if the safety valve should not happen to work properly. When the several steam gauges on a battery of boilers read substantially alike, the attendants easily form the bad habit of consulting only the one which happens to be conveniently situated. Moreover, when a battery of boilers is customarily run as a single unit, the attendants grow a little lax about the safety valves, relying too much on the fact that there are a number of these valves, so that the probability of not getting relief from some one of them at least is very small. However much care is exercised in setting the various safety valves on a battery of boilers, they cannot all be made to blow at precisely the same pressure; and the one that blows first is apt to be the one that does all the work, and gets most (or all) of the attention.

When these various facts are taken into consideration, it will be seen that even when boilers are run in a battery, it is by no means impossible for the pressure to rise to a dangerous point on some one or more of them. The writer recalls a particularly serious case that came under his observation, in which a boiler that had just been fired up, after being out of service for a few days, exploded with great violence because the stop valve between this boiler and the rest of the battery had not been opened; the result being that four or five men were killed and property valued at from $20,000 to $25,000 was destroyed.

Having considered the causes of over-pressure at some length (though by no means exhaustively), the remedies next present themselves. The very first thing to do in such cases is to deaden the fires, so that the cause of the increase of pressure may be removed at the earliest possible moment. It is quite common to draw the fires, but it is much better to cover them with green coal or ashes. It is often thought that ashes are better for this purpose than coal, presumably because coal is combustible, while ashes are not; but coal is equally good, and, moreover, it is always at hand, while ashes are not. The layer of coal that is applied should be thick and generous, so as to intercept as much as possible of the radiant heat that would otherwise reach the shell of the boiler, and because it is desirable that no considerable amount of air should draw up through the grates. Heat cannot be generated in a furnace without combustion, and combustion cannot take place without air; so that if no draft passes up through the fuel on the grates, there will be no further combustion and therefore no further generation of heat.

When a fire is drawn, the first thing that happens is that the hot bed of coals being stirred up vigorously radiates an extra amount of heat, which not only adds to the formation of steam in the boiler, but also makes it exceedingly uncomfortable for the fireman who is hauling the fire. The personal comfort of the fireman is not a matter of any great immediate importance in an emergency of this kind, it is true, and of course it would not be considered for an instant, even by the fireman himself, except that it has an important bearing upon the quickness with which the boiler can be brought into a comparatively safe condition. No person who has tried it needs to be told that it is impossible to work expeditiously in the face of an intense heat such as emanates from a good hot fire that is being drawn. The fireman must either dump the flaming mass of coals immediately in front of the boiler, where he is exposed to its fierce radiance at unbearably close quarters, or he must consume time that is of the utmost value in thrusting it off to one side. Time is the great element to be considered when a boiler is found to be running at a pressure so high that an explosion, or at least a rupture, is feared. For this reason it may be confidently said that the burying of the fire with a heavy layer of green coal is much better than drawing it.

The moment that the fire has been covered up the danger of rupture of any part of the boiler becomes less, minute by minute. The fire-doors should be left open and the ashpit doors (if there are any) should be kept closed, the idea being that when the fire-doors and ashpit doors are disposed in this way, the tendency for air to pass up through the fire, and sustain the combustion, is reduced to the lowest point possible. The damper is best left closed, because, although the cooling of the boiler would be expedited by opening it and leaving the fire-doors open at the same time, the cool air that would be thereby drawn in against the boiler would be liable to cause local contractions sufficient to throw additional strain upon the boiler, and this is the very thing that must not be done.

The general principle to be followed is to avoid doing anything whatever that might throw an additional stress upon the boiler, or lead to a sudden redistribution of stresses already existing. In particular, this rule of action forbids the safety valve to be opened when the pressure is dangerously high, if the valve did not open of its own accord. If the pressure is away above the blowing point of the valve, and the valve is suddenly opened, it will discharge with great force, so that there is grave danger of the water in the boiler being lifted bodily and hurled against the shell. This would cause stresses of most serious magnitude, and might lead to a rupture at once. Even if the water were not thrown up against the shell, the sudden redistribution of stress that would almost certainly follow any such considerable outflow of steam might lead to disastrous consequences, since, as is well known, a moving load strains more severely than the same load would if it were stationary or "dead." Many boiler explosions occur just at the moment the engine is started, after the boiler has been lying quiet for a time. The sudden draft of steam apears to make the pressure in the boiler act more like a "live" load than like a "dead" load, and the boiler, which was strained almost to the limit of its strength under the previous "dead" load, gives way. If the boiler has successfully resisted the existing state of things, whatever they may be, up to the time that the fires were covered, the best plan is to avoid any sudden change in these conditions.

Some authorities consider that there is no harm, after the fire has been well covered and the doors and damper set as recommended above, in slowly pumping in more feed water, provided the feed pipe has a course of considerable length inside the boiler, so that the water that enters is nearly at the boiler temperature before it is finally discharged into the general circulation. It is true that the addition of cold feed water in this way will tend to reduce the temperature of the boiler somewhat, and so hasten the establishment of safe conditions; but if feed is introduced in this manner at all, it must be handled with good judgment, for the too rapid introduction of cold feed may be far worse than letting the boiler alone. The use of feed water in this way is not to be recommended, as it is a violation of the fundamental rule for safety already given.

Some persons also recommend that the blow-off be opened cautiously and slowly, in order to allow some of the heat energy of the boiler to escape. It is not easy to understand what can be gained in this way. Certainly the boiler is not sensibly cooled by abstracting some of its water, for the water that remains is still at the same temperature as it was before any was drawn off. It may be admitted that the boiler will cool quicker after some of its water has been removed, and that an explosion in which there is little water in the boiler is not, in general, so disastrous as one in which there is plenty of water in the boiler. The removal of water through the blow-off would therefore tend to reduce the damage, if an explosion should finally occur; but the likelihood of an explosion is less if neither the feed nor the blow-off is touched.

The general method of procedure may be summed up as follows: In case of dangerously high pressure (1), cover the fire at once with a thick layer of green coal; (2) leave the fire doors open, and close the ashpit doors; (3) leave the damper closed; (4) do not touch the feed valve nor the blow-off; (5) above all, do not open the safety valve, nor touch it in any way; and (6) in all respects leave the boiler to itself, except for the positive directions here given.

After things have resumed their normal state, the safety valve may be examined, to see why it did not work. If the circumstances of the emergency have been such that no doubt whatever is felt about the safety of the boiler at ordinary pressures, it may be run until such time as it is convenient to examine it, but if the smallest doubt is felt about it, it should be put out of service at once, and be thoroughly examined, inside and out, before being run again.

Another very common emergency in the boiler room consists in the water level being too high or too low. The attendant will suddenly discover that no water can be seen in the glass. This may signify either that the glass is full, or that it is empty; and the first thing to do is to settle which is the case, by the use of the try-cocks. If the water is too high, the boiler is in no particular danger, but there is likelihood of the water being carried over into the steam pipe and wrecking the engine.

The obvious remedy for excess of water in the boiler is to open the blow-off valve and let the level fall to the proper place. If the valve on the blow-off is a plug cock, it should be opened wide; but if it is a gate or globe valve it need not be opened full, although in such cases it should be thrown wide open for a moment at least, just before closing, in order that any sediment or fragments of scale that may have passed into the pipe may be swept out.

It occasionally happens, in blowing down a boiler in this way, that the blow-off is left open too long, with the result that when the attendant again looks at his gauge glass the glass appears to be still full, whereas it is in reality empty. Numerous accidents have happened in this way, the attendant continuing to blow, under a misapprehension, when the water level has fallen below where it should normally stand. The obvious way to prevent such an accident is to give close attention to the gauge glass from the moment the blow-off is opened until the water falls to the correct level.

If the water is low instead of high, the first thing to do is to cover the fire with a thick layer of green coal and open the fire-doors and close the damper, just as in the case of too great a pressure. Then if the attendant is perfectly sure that the water level has not fallen far below the lowest point at which it could be seen in the glass, he may safely turn on the feed water and bring the level up to its proper place. Before he does this, however, he must be positive that the level is not far below the usual place. For example, he may be positive that there was plenty of water in the boiler only a short time before, and a careful examination of the blow-off and a look into the furnace and the back connection may satisfy him that no leakage has taken place either through the blow-off or through any fracture or started joint that may have suddenly developed. In case there is no evidence of loss of water from any such causes as these, his previous experience with the plant, when considered in relation to the time that has elapsed since he last knew the water level to be right, might enable him to infer with a high degree of probability that the water level cannot have fallen far below its normal position. This point may be tested further, in case a combination water column is used, by opening the cock at the bottom of the column that is used for blowing the column out. It is probable that water will be obtained at this cock if the level has not fallen to a dangerous place. Moreover, if the boiler is provided with a safety fusible plug correctly located, and known to be in good condition, the fact that this plug has not blown out may be taken as additional evidence that the water level has not fallen very far. But if the attendant has the slightest doubt about the position of the water level, he must not turn on the feed at all, but must let the boiler cool down. This advice is given, not because there is any serious danger of the feed water flashing instantly into steam, as it is popularly supposed to do, but merely in accordance with the general principle already stated, that so long as nothing in the way of a serious accident has yet happened, the proper thing to do is to avoid any act that may throw additional strain upon any part of the boiler, either by sudden contraction of the plates or in any other way.

If the boiler is one of a battery, it had better be shut off from the rest of the battery as soon as its fire has been covered with coal, for otherwise the pressure could not fall, and the boiler could not cool to a point materially below that of the other boilers with which it is connected, because steam would keep pouring into it from the others so long as the stop valve remained open. It sometimes happens, when the water level has fallen a good way, that the steam that has been passing out of the boiler has been so highly superheated from contact with the over-heated plates, that it has melted the seat from the stop valve. In this case the valve might be closed to all appearances, while still leaking so badly that steam could pass freely from the rest of the battery into the boiler that is supposed to be shut off. In such an event, the true state of things will probably not be discovered for some time; not, in fact, until time enough has elapsed to expect a considerable fall in pressure in the isolated boiler, and the expected fall does not occur. The time that would naturally be required to produce a visible fall in pressure in a boiler that is isolated, and has had its fire covered as already recommended, will vary a good deal with the way in which the boiler is set; for most of the heat that is lost from such a boiler must pass away by radiation, and radiation will be considerably greater in a boiler that is poorly set than it will be in one that is well set. The attendant who has had some experience with the particular plant in which the trouble has occurred will be the best judge of how soon the effects of cooling should make themselves visible in a reduction of the steam pressure; but in general it may be said that no very marked fall of pressure can be expected to occur in less than an hour.

If it appears, after a sufficient time has elapsed, that the stop valve has not effectively shut the boiler off from the others in the battery, the subsequent action of the attendant will depend upon circumstances. If no signs of distress are seen about the boiler in which the water has been down, he may let everything stand as it is until such time as it may be convenient to shut down the whole battery, or at least as much of it as may be necessary to shut down in order to take the pressure off the boiler in which the water has been low. Then the boiler should be opened and examined carefully inside and out for signs of damage. If no evidence of such damage can be found, the boiler may then be put into service again.

If, on the other hand, the boiler shows signs of incipient rupture (as, for instance, by the establishment of a leak which slowly increases), it becomes imperative to shut the boiler off from the rest of the battery by closing the stop valves on the individual boilers, or in any other way that the arrangement of the piping about the plant may suggest.

It might be thought that after covering the fire and getting the boiler isolated, the best thing to do, under any circumstances, would be to ease up the safety valve cautiously, or else to open the connection that is frequently provided for the flue cleaner; but this should not be done unless there is evidence that the boiler may give way under the pressure to which it is exposed. It is true that the cautious reduction of pressure in this way would not be likely to produce any great changes of stress in the boiler, and when looked at in this light only, it would be a safe enough thing to do; but it must be remembered that if steam is withdrawn from the boiler, more water will evaporate to take its place and as the water is supposed to be so low already that the boiler is in a dangerous condition, it is plain that it would be unwise to do anything that would tend to lower the water level still more. It may be that things are on the verge of giving out, and that the least further fall of the water level would precipitate matters. To illustrate the reality of this source of danger, the writer has calculated the amount of evaporation that would be caused by easing up the safety valve, and found that if the boiler was originally run at 100 lbs., and the pressure were reduced by allowing steam to escape through the safety valve, then by the time the pressure had fallen to that of the atmosphere, something like one-seventh of the water that was in the boiler at the time the safety valve was opened would have evaporated into steam, even if there were no absorption of heat from the furnace. If the furnace and the hot brickwork of the setting contributed some heat, as of course they would, then the fall in the water level from opening the safety valve would be still greater. It is therefore evident that the valve should not be opened unless there are signs that a rupture will occur shortly unless the pressure is reduced, and in that case it will be better, of course, to take chances of burning the boiler rather than take the chance of an explosion.

The only other emergency that will be considered in this place is the sudden rupture of some part of the boiler, with the resulting escape of steam and water into the fire room. This may occur from the bursting or collapse of a tube, by the bursting of the blow-off pipe or the failure of its attachment to the boiler, by the fracture of a header, or in any other of a great multitude of ways. The first thing to do in any case is to turn on the feed water, for this will have the double advantage of keeping the water level up as well as possible and of cooling the contents of the boiler, and so checking the formation of steam. If the rupture is slight, so that the attendant can work in front of the furnace doors, he should next cover the fires as quickly as possible with a thick layer of green coal, just as in the case of low water and high pressure. If the outflow of steam and water is so great that it is impossible to work in front of the furnace doors, the chances are that the steam and water will themselves deaden the fires sufficiently, and it often happens in an emergency of this kind that the whole fire, or at least most of it, is blown bodily out into the room, so that there is more danger of burning the boiler house than of burning the boiler. The fractured boiler must be isolated from the rest of the battery as soon as possible, of course, in order that the contents of the whole battery may not be discharged through the breach.

A single word about the care of a man who has been burned or scalded may not be out of place. Of course the first thing to do is to send for medical assistance, but in the interim the injured man's clothing should be removed, and bandages soaked with sweet oil and lime water should be lightly applied to the burned parts. If steam has been inhaled, sweet oil should also be swallowed by the patient in considerable quantity, as it will soothe such of the burned parts as it can reach. Sweet oil and lime water should be kept about every steam plant, to provide for contingencies of this sort. Cooking soda (saleratus) is also very soothing when applied to burns, and castor oil in moderate quantity may be given internally in the place of sweet oil.

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UNIVERSAL WIRING TABLE.

BY ARTHUR R. ROE.

In arranging the accompanying table advantage has been taken of the fact that in the B. & S. gauge, wires from 0000 to 6 have ten times the cross-sectional area of wires from 7 to 16. For instance, No. 1 has an area of 83,694 circular mils and No. 11 has 8234 circular mils; No. 4 has an area of 41,742 circular mils, and No. 14, 4106 circular mils. So, whatever current No. 1 or No. 4 will carry at a given "drop," No. 11 or No. 14 will carry respectively one-tenth of that current with the same drop.

In the table the large figures in the two upper horizontal rows give the sizes in B. & S. gauge, the sizes from No. 0000 to No. 6 occupying the upper row, and the sizes from No. 7 to No. 16 the lower row, each size in the lower row being one-tenth the area of the size immediately above it. The small figures in these rows give the carrying capacity in amperes of the wire size in which column they are found, the upper figure giving the amperes required for a density of 1000 amperes per square inch, the small figure immediately below the gauge number giving the maximum amperes for rubber-covered wire, and the lowest small figure the maximum amperes for weather-proof wire, both according to the National Electrical Code. The numbers in the body of each table give the load in ampere—feet (ampere×distance or length of *one* wire) for the different wire sizes. The left-hand vertical column applies to the upper row of wires and the right-hand column to the lower row.

The table becomes universal by applying any multiple or sub-multiple of 10. For example, at one volt loss No. 0000 wire has a capacity of 9842 ampere-feet, and at 0.1 volt loss the capacity is 984.2 ampere-feet. Similarly, at 10 volts loss the capacity is 98.418

Volts Loss Nos. 0000 to 6 Wire.	211,600 167 **0000** 210 312 20,816 16 **7** 39 55	167,805 132 **000** 177 262 16,508 13 **8** 33 46	133,079 105 **00** 150 220 13,094 10 **9** 28 37	105,592 82 **0** 127 185 10,381 8 **10** 24 32	83,694 66 **1** 107 156 8234 6.5 **11** 20 27	66,373 52 **2** 90 131 6529 5 **12** 17 23	52,633 41 **3** 76 110 5178 4 **13** 14 19	41,742 34 **4** 65 92 4106 3 **14** 12 16	33,102 26 **5** 54 77 3256 2.5 **15** 9 12	26,250 21 **6** 46 65 2582 2 **16** 6 8	Volts Loss Nos. 7 to 16 Wire.
¼	2460	1951	1547	1228	973	772	612	485	385	305	2½
½	4921	3902	3095	2455	1946	1543	1224	971	770	610	5
¾	7381	5853	4642	3683	2919	2315	1836	1456	1155	916	7½
1	9842	7805	6190	4911	3893	3087	2448	1941	1539	1221	10
1¼	12,302	9756	7737	6139	4866	3859	3060	2427	1924	1536	12½
1½	14,763	11.707	9284	7367	5839	4631	3672	2912	2309	1831	15
1¾	17,223	13,658	10,832	8594	6812	5402	4284	3397	2694	2136	17½
2	19,683	15,609	12,379	9822	7785	6174	4896	3883	3079	2442	20
2¼	22,143	17,561	13,927	11,050	8759	6946	5508	4369	3464	2747	22½
2½	24,604	19,512	15,474	12,278	9732	7718	6120	4854	3849	3052	25
2¾	27,065	21,463	17,022	13,506	10,705	8490	6732	5339	4234	3357	27½
3	29,525	23,414	18,569	14,733	11,678	9261	7344	5825	4619	3663	30
3¼	31,986	25,365	20,117	15,961	12,651	10,033	7956	6310	5004	3968	32½
3½	34,446	27,317	21,664	17,189	13,625	10,805	8568	6795	5388	4273	35
3¾	36,907	29,268	23,211	18,417	14,598	11,577	9180	7281	5773	4578	37½
4	39,367	31,219	24,759	19,645	15,571	12,349	9792	7766	6158	4884	40
4¼	41,827	33,170	26,306	20,872	16,544	13,120	10,404	8251	6543	5189	42½
4½	44,288	35,121	27,854	22,100	17,517	13,892	11,016	8737	6928	5494	45
4¾	46,748	37,073	29,401	23,328	18,491	14,664	11,628	9222	7313	5799	47½
5	49,209	39,024	30,949	24,556	19,464	15,436	12,240	9708	7698	6105	50
5¼	51,669	40,975	32,496	25,784	20,437	16,208	12,852	10,193	8083	6410	52½
5½	54.130	42,926	34,044	27,011	21,410	16,979	13.464	10,679	8468	6715	55
5¾	56,590	44,877	35,591	28,239	22,383	17,751	14,076	11,164	8853	7020	57½
6	59,051	46,829	37,139	29,467	23.357	18,523	14,688	11,649	9237	7326	60
6¼	61,511	48,780	38,696	30.695	24,330	19,295	15,300	12,135	9622	7631	62½
6½	63,972	50.731	40,233	31,929	25,303	20,067	15,912	12,620	10,007	7936	65
6¾	66,432	52,682	41,781	33,156	26,276	20,838	16,524	13,105	10,392	8241	67½
7	68,892	54,633	43,328	34,378	27,249	21,610	17,136	13,591	10,777	8547	70
7¼	71,353	56,585	44,876	35,606	28,223	22,382	17,748	14,076	11,162	8852	72½
7½	73,813	58,536	46,423	36,834	29,196	23,154	18,360	14,562	11,547	9157	75
7¾	76,274	60,487	47,971	38,062	30,169	23,926	18,972	15,047	11,932	9462	77½
8	78,734	62,438	49,518	39,289	31,142	24,697	19,584	15,533	12,317	9768	80
8¼	81,195	64,390	51,066	40,517	32,115	25,469	20,196	16,018	12,702	10,073	82½
8½	83,655	66,341	52,613	41,745	33,089	26,241	20,808	16,503	13,086	10,378	85
8¾	86,116	68,292	54,160	42,973	34,062	27,013	21,420	16,990	13,471	10,683	87½
9	88,576	70,243	55,708	44,201	35,035	27,785	22,032	17,472	13,856	10,989	90
9¼	91,036	72,194	57,255	45,428	36,008	28,556	22,644	17,959	14,241	11,294	92½
9½	93,497	74,145	58,803	46,656	36,981	29,328	23,256	18,445	14,626	11,599	95
9¾	95,957	76,097	60,350	47,884	37,955	30,100	23,868	18,930	15,011	11,904	97½
10	98,418	78,048	61,898	49,112	38,928	30,872	24,480	19,416	15,396	12,210	100

ampere-feet, and at 100 volts it is, of course, increased ten-fold.

In order to use the table it is only necessary to multiply the single distance in feet (the length of one wire) by the load in amperes. As above stated, the product is ampere-feet, and the table shows all the combinations of drop and wire size that correspond to any given number of ampere-feet. For example, if the ampere-feet should be 9500, the table shows that No. 0000 wire will carry this load at 1-volt drop, No. 000 at 1¼ volts drop, No. 0 at 2 volts drop, No. 1 at 2½ volts drop, No. 3 at 4 volts drop, and so on. To illustrate the use of the table more explicitly, suppose it is desired to deliver 10 amperes over a line 700 feet long with a loss of 3 volts. The ampere-feet will be 10 × 700 = 7000. Referring to the 3-volt line of the table, taking the 3 volts in the left-hand edge column, the nearest number to this is 7344 ampere-feet, and at the head of the column in which this number is located are Nos. 3 and 13. As the left-hand "drop" column applies only to the upper row of figures, the size of wire to be taken would be No. 3. If the drop had been 30 volts instead of 3, then No. 13 would have been the proper size of wire.

Again, suppose that it were desired to deliver 15 amperes over a distance of 600 feet with a drop of 15 volts. The ampere-feet would be 15 × 600 = 9000, and tracing into the table from 15 volts in the right-hand column, the nearest number is 9284; at the head of this column are Nos. 00 and 9, and as the right-hand "drop" column was used, No. 9 is the proper size of wire.

The examples given below will indicate the flexibility of the table by the use of multiples or sub-multiples of 10.

Amperes	Feet	Ampere-feet	Volts Loss	Size Wire
35	265	9,275	1.5	9
35	2,650	92,750	15.0	9
35	26,500	927,500	150.0	9
35	26,500	927,500	15.0	00
35	2,650	92,750	1.5	00

ENGINE SAFETY STOPPING DEVICES.

BY JAMES F. HOBART.

The perfection of the engine safety stop has carried it into many forms to suit the requirements of various engines, but there is a considerable resemblance among them all. Fig. 1 shows a very common form of engine stop, in which the valve-actuating force is a weight, and the controlling appliance is actuated by electricity. This makes a very good combination, and embodies a principle which it is well to keep in mind, namely, never use electricity for doing a thing when it can be done as well or better by mechanical means. In Fig. 1 the valve (which in this case is represented as being of the plain butterfly variety) is closed by the weight, *E*, whenever it is released by the toggle and hook, *C, D, E.* This mechanism is held in place by the hook *B*, acting through gravity. When an impulse is sent through magnet *AA*, by closing an electic circuit at any convenient point, the hook *B* is tilted, the toggle released, the weight falls, and the steam valve is quickly closed. Whenever it is desired to operate the apparatus manually it is only necessary to raise the end of the lever *a*, which releases the end of a weighted lever *b*, pivoted at *d*. The weight throws this lever down, and the cam *c* on the other side of the pivot raises the latch *B*, releasing the the depression of a push-button at any point, weight. The arrangement of the levers *a* and *b* is more clearly shown in Fig. 2.

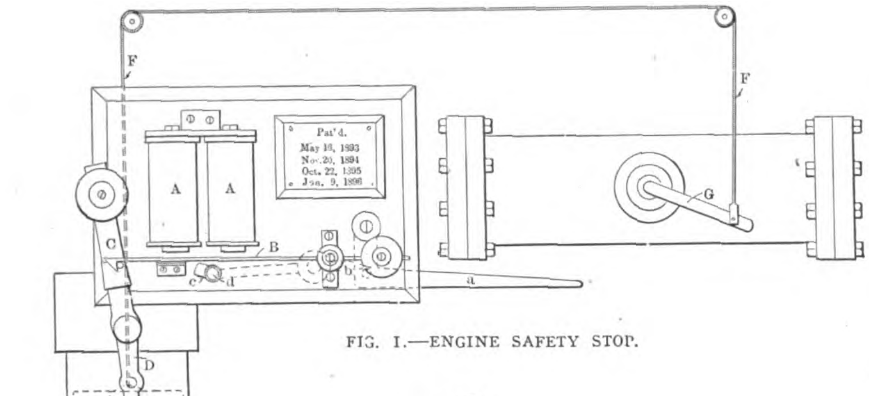


FIG. 1.—ENGINE SAFETY STOP.

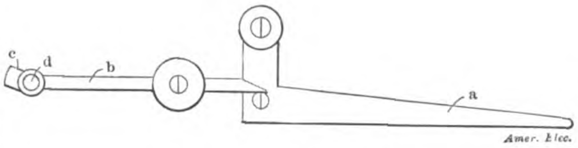


FIG. 2.—DETAIL OF LEVERS.

Fig. 3 shows an auxiliary mechanism which is used for actuating the stop when the engine races. The framework carrying the rod *C* is mounted on the flywheel in such manner that the effect of centrifugal force upon the weight *A* is in the proper direction to throw the rod *C* to the right. This weight *A* is in the proper direction to throw the rod *C* to the right. This tendency is restrained by the spring *B* until the speed exceeds a predetermined limit when the rod *C* is thrown outward, as indicated by the dotted lines. The mechanism is so arranged that when the rod is thrown out it strikes the end of the lever *a*, Figs. 1 and 2, raising that lever and tripping the engine stop. This arrangement is manufactured by the Elmira Safety Appliance Company, Elmira, N. Y.

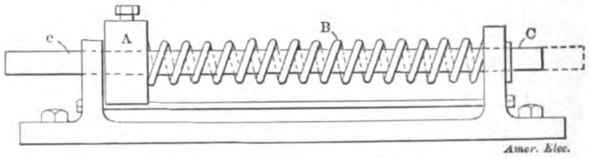
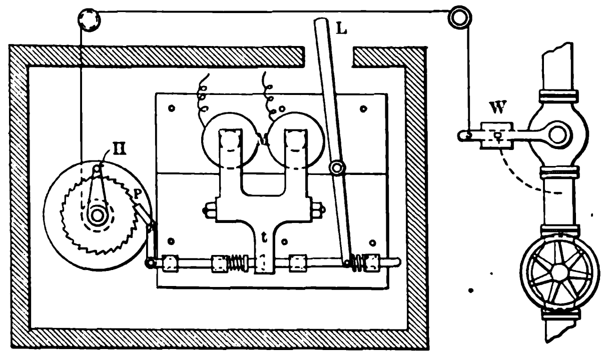


FIG. 3.—AUXILIARY MECHANISM.

The engine stop illustrated by Fig. 4 and manufactured by the W. W. Hailstone Manufacturing Company, Grand River, Ohio, is also provided with both electric and manual release. The electromagnet, *M*, attracts the U-shaped armature in response to and the tongue, *t*, trips the pawl, *P*, allowing the weight *W* to close the throttle. The stop mechanism is enclosed in a box, through the top of which the lever *L*, for manual operation, projects, and through the side of which the spindle of the ratchet wheel projects, carrying a crank and handle, *H*, for re-setting the device. The use of the ratchet enables the throttle valve to be set at any desired point without affecting the operation of the automatic stop.

Fig. 5 shows the direct attachment of the electric stop motion to the stop motion of an engine without the intervention of cords or other apparatus. In this case the work of stopping is performed by the helical spring, *S*, shown in section in the illustration. The plunger-head *A* is connected direct by means of a bell-crank with the throttle. In the case of a jet condensing engine, another machine may be located beside the condenser and attached directly to the



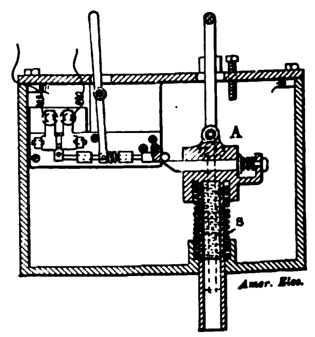


FIG 4.—ELECTRICALLY OPERATED SAFETY STOP.—FIG. 5.

shifting valve, thereby admitting air to the condenser and destroying the vacuum at the instant the main engine stop is operated, so that there can be no tendency of the engine to run along under condenser alone.

Fig. 6 represents the J. K. Wright independent automatic engine stop for steam engines and steam pipe. The point of excellence of this device is that it requires no manual setting whatever when the engine is started. Such setting as may be necessary is automatically performed by the device itself. This device, although similar in action, must not be confused with the automatic safety stop device represented by Fig. 7, which is applied direct to the governor spindle of any engine.

Referring to Fig. 6, the governor spindle *a*, is screwed into the end of a small cylinder *b*, within which is a piston, *c;* this piston is normally locked in the position shown by a small bolt, *d*, in which position it holds under compression a coiled spring between its lower end and the lower end of the cylinder, *b*. The bolt, *d*, is normally forced inward by one arm of a triple bell-crank, *e*, under the influence of the coiled spring pressing against the arm, *f*, of the bell-crank. Under normal conditions of operation the whole system is maintained in the position shown in the engraving, so that the arms, *f* and *g*, of the bell-crank do not touch the respective stops *f'* and *g'*. This rigging is balanced by means of the weight, *W*, on one arm of a lever pivoted at *j*. Should the speed of the engine become excessive, the governor will draw the spindle, *a*, upward, pulling the arm, *f*, of the bell-crank against the stop *f'*, and withdrawing the bolt, *d;* as soon as the piston, *c*, is released by the bolt, the coiled spring beneath it throws it upward, pulling the eye, *h*, into contact with the pawl, *p*, and releasing the ratchet drum, *r*, which closes a throttle through the medium of the cord, *s*, under the action of a strong spring within the drum. A similar result follows from a reduction in speed below a predetermined point. In this case the rigging is lowered by the governor until the bolt, *d*, is thrown by reason of the arm, *g*, coming into contact with the stop, *g'*. At *k* is an attachment whereby the safety stop may be rendered inoperative when it is desired to shut the engine down in the ordinary way.

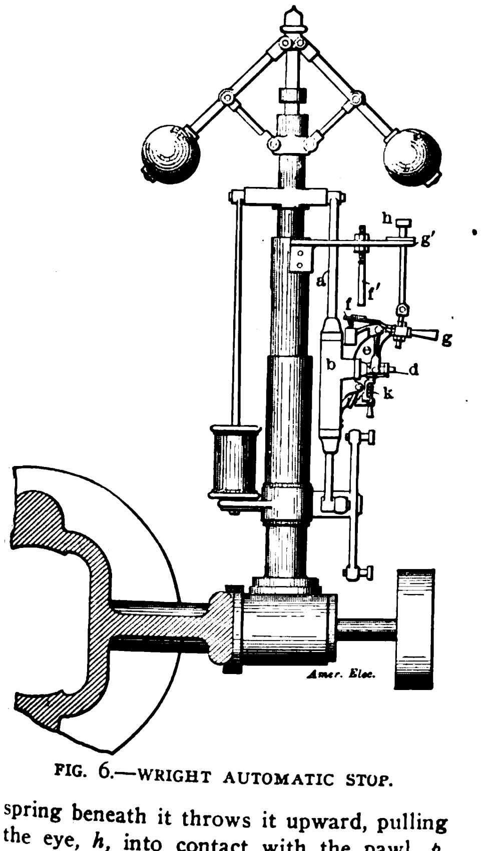


FIG. 6.—WRIGHT AUTOMATIC STOP.

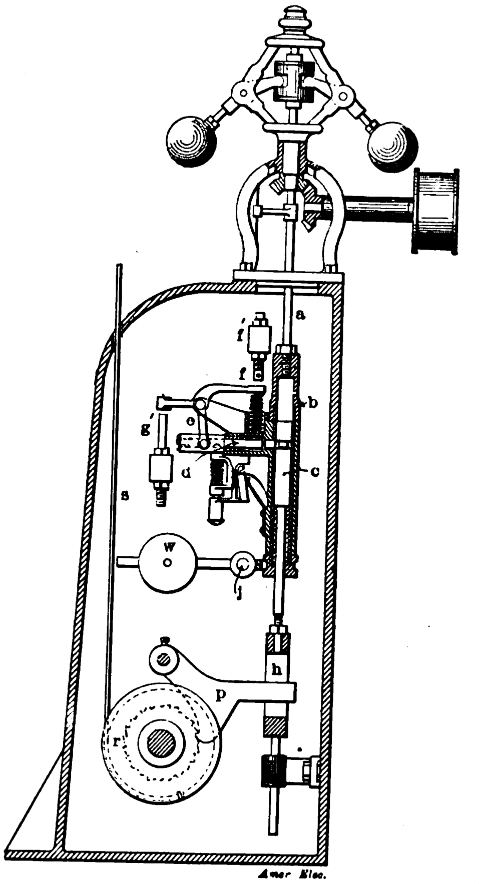


FIG. 7.—INDEPENDENT AUTOMATIC STOP.

The action of the stop shown in Fig. 7 is very similar. The cylinder, *b*, contains a plunger and spring exactly like that in Fig. 6, the plunger being locked with the spring under compression by the bolt, *d*, as in the former case. If the speed is excessive the whole rigging is drawn upward until the tongue, *f*, is drawn into contact with the stop, *f'*, thus throwing the arm, *e*, outward and withdrawing the bolt, *d*. A similar result is obtained when the speed is too slow, the head, *h*, of the link attached to the arm, *g*, being drawn into contact with the stop *g'*, and throwing out the bolt. The arrangement at *k* is a locking device to render the automatic stop inoperative. In this case the stop does not close a throttle but actuates the governor reach rods, as to bring the knock-off cam of the valve-gear under the trip pallets and prevent the steam valves from opening.

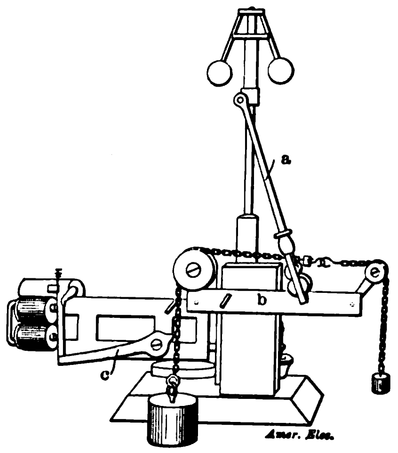


FIG. 8.—SPRINGFIELD ENGINE STOP.

Figs. 8 and 9 illustrate an emergency stop made by the Springfield Engine Stop Company, Springfield, Mass. In this arrangement no attempt is made to control any part of the engine or valve-gear automatically. It is intended only to stop the engine when a push-button is pressed at any part of the plant. The operation of the device will be clear from an inspection of the illustrations. Fig. 8 shows the stop in its normal position. The auxiliary rod, *a*, is pivoted to a collar on the governor spindle at its upper end, and carries at its lower end a grooved roller adapted to travel along a short track, *b*. The chain shown in the engraving is attached to this end of the rod, *a*, and the heavy weight at the left-hand end of the chain is held up by a pawl, *c*, which in turn is held in position by a latch forming the armature of an electromagnet. In case it is desired to stop the engine, a push-button is pressed, energizing the magnet and causing its armature to release the lever, *c*, allowing the heavy weight to draw the lower end of the rod, *a*, over to the left. This movement obviously raises the collar on the governor spindle, as shown in Fig. 9, and throws the valve-gear to the position of no admission.

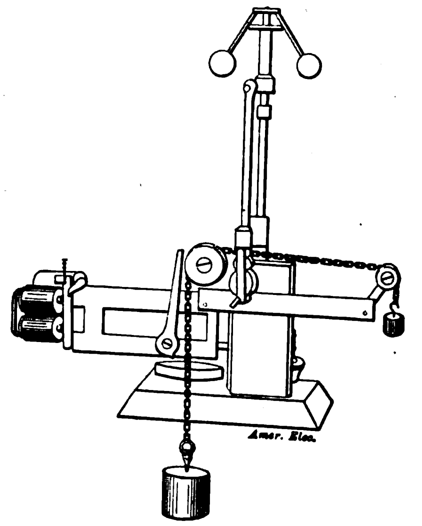


FIG. 9.—SPRINGFIELD ENGINE STOP.

National Association of Stationary Engineers.—The twenty-first annual convention of this association will be held in Boston, September 1 to 6. The headquarters of the convention will be at the Massachusetts Institute of Technology, and the hotel headquarters will be the Brunswick, which is situated directly opposite the institute. The committee in charge of the matter, however, has arranged for delegates who desire to do so to stop at other hotels. Advance arrangements for hotel accommodations can be made through Mr. J. H. Whittemore, 85 Antrim street, Cambridge, Mass.

POINTS TO BE OBSERVED IN REWINDING COIL-WOUND ARMATURES.

In most cases, when a small motor or dynamo goes to a repair shop to have its armature rewound, the repairer contents himself with duplicating the original winding and connections of the builder of the machine, and this is all right—sometimes. It frequently happens, however, that the winding can be improved upon materially, by merely using a simpler winding scheme, if the machine is multipolar.

There are two general plans of multipolar winding: multipath and two-path. The term "two-path" is not always a literal definition, however, as there are windings of this class in which there are more than two paths from brush to brush. While such windings have in fact a multiplicity of paths, they are not included in the multipath class for reasons which will appear later. If the armature of a multipolar machine has only two sets of brushes and no cross connections in the commutator or between the commutator and the armature, the armature winding is necessarily of the two-path variety, although there may be two or more distinct two-path windings on it which are connected in parallel by the brush contact on the commutator, but in a simple two-path winding there are actually only two paths through the armature from brush to brush. In small machines there is no good reason for using plural windings and in large machines there is no excuse for using two-path windings at all.

If there are as many sets of brushes as there are magnet poles, or if there are two sets of brushes and the armature coils or commutator segments are all cross-connected by a system of connections each of which extends around half the circumference in a four-pole machine, one-third the circumference in a six-pole machine or one-fourth the circumference in an eight-pole machine, the armature has as many paths in parallel as there are holes on he field magnet—it has one or more multipath windings.* There are two classes of multipath winding, one known as the "lap" winding, in which any one path through the armature coils from brush to brush passes under only one field-magnet pole; and one known as the multipath "wave" winding, in which each path through the winding passes under every pole on the machine.

This latter winding is not identical with the plural two-path windings mentioned above, although they are wave windings, too. In a machine having a simple lap winding the terminals of any one coil are connected to two commutator segments which are next to each other; any other mode of connection will give either a multipath wave winding or a plural winding; the latter consists of two or more distinct windings interlaced on the armature and connected to alternate commutator segments. As such windings are not necessary on small machines, they will not be discussed here further than to indicate how they may be identified when an armature is to be repaired which has been operated with a winding of this class. An armature having a plural lap winding will always have the terminals of any one coil connected to two commutator segments between which there is either one or two other segments. If there is a single segment intervening between the two to which a coil is connected, the winding is a double lap winding, consisting of two distinct windings connected to alternate commutator bars. If there are two commutator bars between the two to which the terminals of any one coil are connected, the winding is a triple lap winding, that is, three distinct lap windings, each connected to one-third of the commutator bars, but not to each other. Fig. 1 herewith shows one coil of a simple lap winding, Fig. 2 shows two coils of a double lap winding, and Fig. 3 shows three coils of a triple lap winding connected properly to a commutator. These connections are invariable; if the terminals of an armature coil are carried to commutator segments more than $\frac{1}{p}$th of the commutator circumference apart ($p=$ number of poles), the winding is *not* of the lap class.

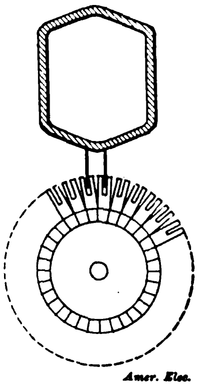

Amer. Elec.

FIG. 1.

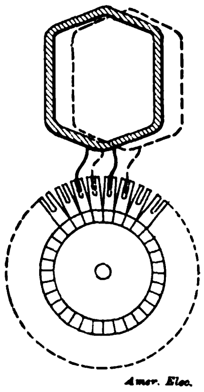

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FIG. 2.

The number of coils in a lap winding may be either even or odd in 6-pole and 10-pole machines, but must be even in 4-pole, 8-pole and 12-pole machines. In rewinding a lap wound armature operated with p sets of brushes the same kind of winding should be put on that was originally on, unless the conditions allow the substitution of a multiple wave winding. If the armature had a cross-connected lap winding, with only two sets of brushes, it will be preferable to replace it with a two-path winding having one coil less, and put a "jumper" between two of the commutator bars so as to make the effective number one less than before. If the cross-connected lap-winding was a plural winding, make the two-path winding similarly plural. Whether or not the winding is a plural one may be ascertained by testing two adjacent commutator segments; if a magneto does not ring when the terminals are applied to two such segments, the winding is plural; if it does ring, it is a simple winding. If the magneto rings between two segments between whch one other segment lies, the winding is double; if it is necessary to touch two segments with *two* others between in order to get a ring, the winding is triple.

When there are p sets of brushes on a machine, the winding may belong to any one of the classes mentioned, and an examination of the commutator connections is necessary in order to classify it. The connections characteristic of the multipath lap winding have been just described.

TWO-PATH WINDINGS.

As previously stated, a multipolar machine with two sets of brushes and no cross-connections necessarily has two-path winding, so that such a winding may be identified by mere inspection. Whether or not the winding is plural can be easily determined in the manner described above with reference to lap windings. In a simple two-path winding the number of armature coils must be

In 4-pole and 8-pole machines, any odd number.

In 6-pole machines, any number not divisible by 3.

In 10-pole machines, one more or one less than any multiple of 5.

In a double two-path winding the number of coils must be twice as great, and in a triple two-path winding three times as great, as in a simple two-path winding. A double two-path winding, therefore, cannot have an odd number of coils under any conditions, so that it can be identified in a two-path 4-pole or 8-pole machine by simply counting the commutator segments, without making the magneto test. In a 6-pole machine the test is necessary, and it is always necessary to identify a triple winding.

If the armature is slotted, as all armatures of modern date are, the number of armature coils will be either the same as or a multiple of he number of slots, or else one less than one of these. Thus, it is frequently the case that an even number of slots is used for an odd number of coils, one coil being left "dead" and put on the core merely to give mechanical balance; and again, it often occurs that the number of actual coils is twice the number of slots, and one coil is left "dead" in order to obtain an odd number of active coils. The number of active coils can always be ascertained from the number of commutator segments, and (in the case of a simple two-path winding) must be adhered to in the new winding.

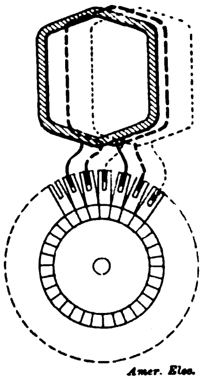
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FIG. 3.

The commutator connections for a simple two-path winding may be determined readily by reference to Fig. 4 and Table I. The sketch shows merely the end of a commutator with the terminals of a coil attached to two of the segments, and the intervening segments indicated by the letter x. As intimated previously, the number of these intervening segments is the key to all winding schemes. Table I gives the number of segments that must be left between the two terminals of each coil in order to obtain a two-path winding, for a large practical range of coil numbers. The general formula for this number, x, is

---

*There is an exception to this rule in the two-path winding with as many sets of brushes as there are poles. This arrangement is highly objectionable and is seldom used.

$$\frac{2s \mp 2}{p} - 1 \qquad (1)$$

in which *s* is the number of commutator segments, and *p* the number of field magnet poles. It is more convenient, however, to use a specific formula for each number of poles, deduced from the one above, for cases not covered by table. These formulas are given below:

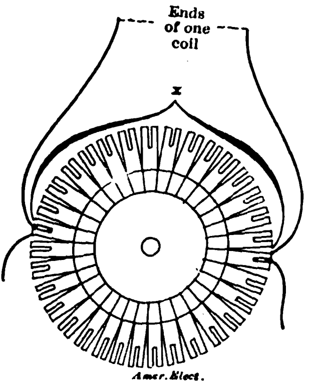


FIG. 4.

FOUR POLES

$$x = \frac{s-3}{2} \qquad (2)$$

SIX POLES

$$x = \frac{s \pm 1}{3} - 1 \qquad (3)$$

s ± 1 *must* be a multiple of 3.

EIGHT POLES

$$x = \frac{s \pm 1}{4} - 1 \qquad (4)$$

s ± 1 *must* be a multiple of 4.

These formulas may be expressed as rules, as follows:

Four Poles.—Subtract 3 from the total number of segments and divide the remainder by 2; the result will be the number x, of segments to be skipped.

Six Poles.—Find the number nearest to the number of segments that is exactly divisible by 3; divide it by 3, and the result will be the number, x, of segments skipped.

Eight Poles.—Find the number nearest to the number of segments that is exactly divisible by 4; divide it by 4 and the result will be the number, x, of segments skipped.

The general formula for the commutator connections of a double two-path winding is

$$x = \frac{2s \pm 4}{p} - 1 \qquad (5),$$

in which 2*s* ± 4 must, of course, be an even multiple of *p*.

The simpler formulas for specified numbers of poles are as follows:

FOUR POLES:

$$x = \frac{s-4}{2} \qquad (6).$$

SIX POLES:

$$x = \frac{s \pm 2}{3} - 1 \qquad (7).$$

s ± 2 must be a multiple of 3.

EIGHT POLES:

$$x = \frac{s \pm 2}{4} - 1 \qquad (8).$$

The eight-pole formula can also be divided into two formulas, thus:

$$x = \frac{s-2}{4} - 1 \qquad (9),$$

and

$$x = \frac{s-2}{4} \qquad (9a).$$

from which it will be evident that there are two permissible values of *x* for an eight-pole machine with a double two-path winding. The preferable value is that given by Formula 9. From these formulas Table II has been prepared, showing the number, *x*, of commutator bars lying between the two to which the terminals of any one coil are connected. In the eight-pole column both of the values for *x* are given, but it should be borne in mind that the smaller value is always preferable.

TABLE II.—COMMUTATOR BARS BETWEEN THE TWO TO WHICH THE TERMINALS OF ANY COIL ARE CONNECTED, IN A SIMPLE TWO-PATH WINDING.

No. of Coils	4 Poles	6 Poles	8 Poles
23	10	7	5
25	11	7	5
26	..	8	..
27	12	..	6
28	..	8	..
29	13	9	6
31	14	9	7
32	..	10	..
33	15	..	7
34	..	10	..
35	16	11	8
37	17	11	8
38	..	12	..
39	18	..	9
40	..	12	..
41	19	13	9
43	20	13	10
44	..	14	..
45	21	..	10
46	..	14	..
47	22	15	11
49	23	15	11
50	..	16	..
51	24	..	12
52	..	16	..
53	25	17	12
55	26	17	13
56	..	18	..
57	27	..	13
58	..	18	..
59	28	19	14
61	29	19	14
62	..	20	..
63	30	..	15
64	..	20	..
65	31	21	15
67	32	21	16
68	..	22	..
69	33	..	16
70	..	22	..
71	34	23	17
73	35	23	17
74	..	24	..
75	36	..	18
76	..	24	..
77	37	25	18
79	38	25	19
80	..	26	..
81	39	..	19
82	..	26	..
83	40	27	20
85	41	27	20
86	..	28	..
87	42	..	21
88	..	28	..
89	43	29	21
91	44	29	22
92	..	30	..
93	45	..	22
94	..	30	..
95	46	31	23
97	47	31	23
98	..	32	..
99	48	..	24
100	..	32	..
101	49	33	24
103	50	33	25
104	..	34	..
105	51	..	25
106	..	34	..
107	52	35	26
109	53	35	26
110	..	36	..
111	54	..	27
112	..	36	..
113	55	37	27
115	56	37	28
116	..	38	..
117	57	..	28
118	..	38	..
119	58	39	29
121	59	39	29
122	..	40	..
123	60	..	30
124	..	40	..
125	61	41	30
127	62	41	31
128	..	42	..
129	63	..	31
130	..	42	..
131	64	43	32
133	65	43	32
134	..	44	..
135	66	..	33
136	..	44	..
137	67	45	33

A double two-path winding gives the same number of paths on a 4-pole machine as a simple lap winding, and a triple two-path winding on a 6-pole machine is the path-equivalent of a lap winding. These windings have the advantage that all electrical troubles due to unbalanced magnetic fields are eliminated, but they have the disadvantage, however, of making the self-induction of short-circuited coils undergoing commutation exactly $\frac{-}{2}$ times as great as is the case with a multipath winding, *p* being the number of poles, as before.

MULTIPATH WAVE WINDINGS.

The numbers of coils that can be used in a simple multipath wave winding are:

Four and Eight Poles.—Any number exactly divisible by the number of poles.

Six Poles.—Any number exactly divisible by 3.

Ten Poles.—Any number exactly divisible by 5.

The number that can be used in a double multipath wave winding is, of course, twice the number that can be used in a simple multipath wave. Consequently, the number of coils on a 4-pole machine must be divisible by 8, and for more than four poles, the armature coils must be a multiple of the number of poles.

It will be noticed that the coil requirements for a simple multipath wave winding are very similar to those for a lap winding. When a lap winding has a number of coils conforming to the rules for a multipath wave winding it can be changed to that form by merely changing the top leads in the commutator lugs, if the leads have been put in symmetrically.

The requirements as to commutator connection for a multipath wave winding are

$$x = \frac{2s}{p} - 2 \qquad (10).$$

and

$$x = \frac{2s}{p} \qquad (10a),$$

showing that there are in general two methods of connection. The first formula is the better one to use, but when it gives such a value for x that makes $x + 1$ have a factor in common with s, then the other

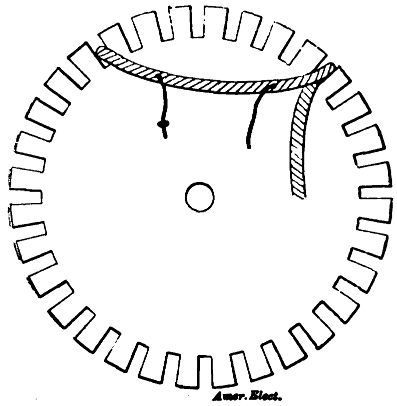


FIG. 5.

formula must be used. For example, if a 6-pole machine has 66 coils, formula 10 would give x a value of 20, and $x + 1 = 21$; this is divisible by 3, and so is 66, so that this spacing cannot be used; the correct value of x is 22.

The formulas for specific numbers of poles are

FOUR POLES:

$$x = \frac{s}{2} - 2 \text{ or } \frac{s}{2} \qquad (11 \text{ and } 11a)$$

SIX POLES:

$$x = \frac{s}{3} - 2 \text{ or } \frac{s}{3} \qquad (12 \text{ and } 12a)$$

EIGHT POLES:

$$x = \frac{s}{4} - 2 \text{ or } \frac{s}{4} \qquad (13 \text{ and } 13a)$$

In every case, the smaller value of x is preferable and should be used if possible.

Table III gives the number, x, of commutator segments that must lie between the two to which the terminals of any one coil are connected in a simple multipath wave winding for a large number of armature coils. It will be noticed that in four-pole and eight-pole machines there are invariably two values for x, while in the 6-pole columns sometimes one and sometimes two values are given. When one is given it is because the other is barred out by the rule, just given, that $x + 1$ must not have a common factor with the total number of coils. If it has, then the winding will not be a multipath wave, but a triple two-path winding, requiring only two sets of brushes. In this connection it may be well to state the proposition that

In a 6-pole multipath wave armature having a number of coils exactly divisible by 9, there are always two permissible values for x; *with any other number of coils there can be but one value for* x.

A multipath wave winding gives the same number of paths through the winding as a lap winding, other features being the same, and it is almost invariably preferable to the lap winding because it eliminates all electrical disadvantages due to unbalanced magnetic fields.

ARRANGEMENT OF COILS.

In placing the coils on any armature core, no matter what the scheme of connections may be, it will always be found preferable to make each coil span a portion of the circumference slightly less than the pole-pitch; that is, slightly less than ¼ the circumference in a 4-pole machine, 1-6 in a 6-pole machine, and so on. With toothed armatures, the number of teeth to be embraced by each coil may be determined by the following rule:

Subtract the number of magnet poles from the number of teeth and divide the remainder by the number of poles; take the whole number nearest the result as the number of teeth to be spanned by each coil.

Putting this rule in the shape of a formula:

$$\frac{t - p}{p} \pm f = \text{teeth embraced},$$

in which t is the number of armature teeth; p, the number of field magnet poles, and f the fractional number added or subtracted in order to get the nearest whole number. For example, if a 4-pole machine has 47 armature teeth, subtracting 4 and dividing by 4 gives 10¼; the nearest whole number is 11, and this would be the proper number of teeth to be spanned or embraced by each coil. Fig. 5 illustrates what is meant by "embracing" the teeth; there are 32 teeth and the coil embraces 7 of them. In a case of this kind, where the number of teeth is a multiple of the number of poles, there is no need to add or subtract a fraction; the formula for coil embrace is

$$\frac{t}{p} - 1 = \text{teeth embraced}.$$

TABLE II.—COMMUTATOR BARS BETWEEN THE TWO TO WHICH THE TERMINALS OF ANY COIL ARE CONNECTED IN A DOUBLE TWO-PATH WINDING.

No. of Coils	4 Poles	6 Poles	8 Poles	No. of Coils	4 Poles	6 Poles	8 Poles
44	..	13	....	160	..	53	....
46	21	15	10-11	162	79	..	41-42
50	23	15	11-12	164	..	53	....
52	..	17	....	166	81	55	42-43
54	25	..	12-13	170	83	55	43-44
56	..	17	....	172	..	57	....
58	27	19	13-14	174	85	..	44-45
62	29	19	14-15	176	..	57	....
64	..	21	....	178	87	59	45-46
66	31	..	15-16	182	89	59	46-47
68	..	21	....	184	..	61	....
70	33	23	16-17	186	91	..	47-48
74	35	23	17-18	188	..	61	....
76	..	25	....	190	93	63	48-49
78	37	..	18-19	194	95	63	50-51
80	..	25	....	196	..	65	....
82	39	27	19-20	198	97	..	51-52
86	41	27	20-21	200	..	65	....
88	..	29	....	202	99	67	52-53
90	43	..	21-22	206	101	67	53-54
92	..	29	....	208	..	69	....
94	45	31	22-23	210	103	..	54-55
98	47	31	23-24	212	..	69	....
100	..	33	....	214	105	71	56-57
102	49	..	24-25	218	107	71	57-58
104	..	33	....	220	..	73	....
106	51	35	25-26	222	109	..	58-59
110	53	35	26-27	224	..	73	....
112	..	37	....	226	111	75	59-60
114	55	..	27-28	230	113	75	60-61
116	..	37	....	232	..	77	....
118	57	39	28-29	234	115	..	61-62
122	59	39	30-31	236	..	77	....
124	..	41	....	238	117	79	62-63
126	61	..	31-32	242	119	79	63-64
128	..	41	....	244	..	81	....
130	63	43	32-33	246	121	..	64-65
134	65	43	33-34	248	..	81	....
136	..	45	....	250	123	83	65-66
138	67	..	34-35	254	125	83	66-67
140	..	45	....	256	..	85	....
142	69	47	35-36	258	127	..	67-68
146	71	47	36-37	260	..	85	....
148	..	49	....	262	129	87	68-69
150	73	..	37-38	266	131	87	69-70
152	..	49	....	268	..	89	....
154	75	51	38-39	270	133	..	70-71
158	77	51	40-41	272	..	91	....

Before any coils are put on a core, one lead of each coil should be marked for identification, either by tying a knot in it, or tagging, or some other reliable method. Then the coils *must* be put on the core in the same manner throughout, so that the marked lead of each coil will have the same relative position as to the unmarked lead that is true of any other coil. Thus, if the left-hand lead of the coil in Fig. 5 be the marked one, then every other coil must be so put in place that when it is on top—when the core is turned to bring the coil into a horizontal position above the shaft—its left-hand lead will be the marked one. This will enable the winder to put the leads in the commutator segments in proper sequence.

The marked leads should all go in first, in precisely the same order as the coils. When two or more half-coils in a single slot are arranged one over another it is a good plan to make the sequence run from inner to outer coils; that is, connect the marked lead of the innermost coil first. When all the marked leads are in, any one of the unmarked leads may be chosen to start on. The segment to which the marked lead of that coil is connected must be identified by a magneto or lamp test, the proper number of commutator bars, x, skipped over, and the free end put in the next commutator lug. After this, a careful winder will not need to make another test to identify coil leads, although it is safer to do so as each lead is put in place. But if all the marked leads have been put in the commutator lugs in uniform sequence, after the lug for first lead has been properly located the remainder can be put in in the same sequence as was observed with the marked leads without testing.

From the foregoing discussion it will be evident that a simple lap winding, with p sets of brushes, may be replaced by a multipath wave or by a plural two-path scheme having $\frac{P}{2}$ windings (double two-paths for four poles, triple for six poles, etc.), or by a simple two-path winding with $\frac{P}{2}$ times as many wires in parallel per coil as the lap winding had, and $\frac{2}{p}$ times as many turns per coil. Also that a cross-connected lap winding with two sets of brushes may (and should) be replaced by a plural two-path, with $\frac{P}{2}$ windings, or by a simple two-path with $\frac{P}{2}$ times as many wires in parallel and $\frac{2}{p}$ times as many turns per coil. In the first case the multipath wave winding is the best; in the second, the plural two-path will probably be preferable mechanically, but the simple two-path is preferable electrically.

TABLE III.—COMMUTATOR BARS BETWEEN THE TWO TO WHICH ANY ONE ARAMATURE COIL IS CONNECTED IN A MULTIPATH WAVE WINDING.

No. of Coils	4 Poles	6 Poles	8 Poles	No. of Coils	4 Poles	6 Poles	8 Poles
24	10-12	6	10-12	147	....	49	....
27	....	7-9	....	148	72-74	....	....
28	12-14	....	....	150	....	48	....
30	....	10	....	152	74-76	....	74-76
32	14-16	....	14-16	153	....	49-51	....
33	....	9	....	156	76-78	52	....
36	16-18	10-12	....	159	....	51	....
39	....	13	....	160	78-80	....	78-80
40	18-20	....	18-20	162	....	52-54	....
42	....	12	....	164	80-82	....	....
44	20-22	....	....	165	....	55	....
45	....	13-15	....	168	82-84	54	82-84
48	22-24	16	22-24	171	....	55-57	....
51	....	15	....	172	84-86	....	....
52	24-26	....	....	174	....	58	....
54	....	16-18	....	176	86-88	....	86-88
56	26-28	....	26-28	177	....	57	....
57	....	19	....	180	88-90	58-60	....
60	28-30	18	....	183	....	61	....
63	....	19-21	....	184	90-92	....	90-92
64	30-32	....	30-32	186	....	60	....
66	....	22	....	188	92-94	....	....
68	32-34	....	....	189	....	61-63	....
69	....	21	....	192	94-96	64	94-96
72	34-36	22-24	34-36	195	....	63	....
75	....	25	....	196	96-98	....	....
76	36-38	....	....	198	....	64-66	....
78	....	24	....	200	98-100	....	98-100
80	38-40	....	38-40	201	....	67	....
81	....	25-27	....	204	100-102	66	....
84	40-42	28	....	207	....	67-69	....
87	....	27	....	208	102-104	....	102-104
88	42-44	....	42-44	210	....	70	....
90	....	28-30	....	212	104-106	....	....
92	44-46	....	....	213	....	69	....
93	....	31	....	216	106-108	70-72	106-108
96	46-48	30	46-48	219	....	73	....
99	....	31-33	....	220	108-110	....	....
100	48-50	....	....	222	....	72	....
102	....	34	....	224	110-112	....	110-112
104	50-52	....	50-52	225	....	73-75	....
105	....	33	....	228	112-114	76	....
108	52-54	34-36	....	231	....	75	....
111	....	37	....	232	114-116	....	114-116
112	54-56	....	54-56	234	....	76-78	....
114	....	36	....	236	116-118	....	....
116	56-58	....	....	237	....	79	....
117	....	37-39	....	240	118-120	78	118-120
120	58-60	40	58-60	243	....	79-81	....
123	....	39	....	244	120-122	....	....
124	60-62	....	....	246	....	82	....
126	....	40-42	....	248	122-124	....	122-124
128	62-64	....	62-64	249	....	81	....
129	....	43	....	252	124-126	82-84	....
132	64-66	42	....	255	....	85	....
135	....	43-45	....	256	126-128	....	126-128
136	66-68	....	66-68	258	....	84	....
138	....	46	....	260	128-130	....	....
140	68-70	....	....	261	....	85-87	....
141	....	45	....	264	130-132	88	130-132
144	70-72	46-48	70-72	267	....	87	....

Lessons in Practical Electricity

FIELD MAGNET EXCITATION.

But for the property that iron and steel possess of retaining more or less magnetism after being once magnetized, it would be necessary to magnetize the field magnet of a dynamo by current drawn from some independent source whenever the machine was started up. The residual magnetism in the dynamo field-magnet, however, enables the machine to generate a faint e.m.f. in the armature when it is first brought up to speed and by connecting the field-magnet winding to the brushes, this faint e.m.f. drives a small current through a winding around the magnet cores and strengthens them magnetically; the least increase in field strength increases the armature e.m.f., and this in turn strengthens the current in the field winding, causing a further strengthening of the field magnet, and so on, until the machine has "built up" its e.m.f. to the normal point.

Just here another peculiar property of iron, which is otherwise objectionable, comes in to make the self-excitation of a dynamo practicable. If the magnetic flux in the field magnet increased continuously in strict proportion to the increase of current strength in the magnet coils, the building up would continue far beyond the normal point and the machine would be unstable —that is, it could not be made to give a steady e.m.f. or a steady current. But the magnetism does not increase in proportion to the magnetizing force of the windings; as explained in a previous Lesson, the permeability of iron decreases as the flux density increases, so that a point is soon reached at which any further increase in magnetic strength would require a greater increase in the magnetizing current than the e.m.f. that would be produced by such a magnetic increase could force through the windings.

There are two fundamental methods of connecting field magnet windings to the armature brushes, and two combinations of these. One is to connect the winding in series with the load, as shown in Figs. 1 and 1-a, and the other is to connect it in parallel with the load, as in Figs. 2 and 2-a.

The first arrangement is called a series field winding, and the second is a "shunt" field winding, the term "shunt" being employed in preference to the descriptive term "parallel" because the proportion of the total current that passes through the field winding is very small, so that the winding is actually a shunt or by-path to the main circuit.

A dynamo with a shunt field winding maintains an almost constant e.m.f. at its brushes when driven at a constant speed; if there were no loss of volts in forcing the current through the armature windings the e.m.f. would remain absolutely constant, but there is, of course, this loss or "drop," and this makes it necessary to provide some means of regulating the e.m.f. Even if there were no armature "drop," regulation would be necessary because of the "drop" in the wires connecting the dynamo with the load, a machine of this character being used to supply a load requiring a fixed e.m.f. Consequently, an adjustable resistance is put in series with the field winding, as indicated diagrammatically in Fig. 3, where *L* is a metal lever arranged to swing around a pivot and touch at its free end any one of a semi-circular row of metal contacts; these are connected to points in a resistance coil—a coil of wire, such as iron, having a relatively high resistance. Moving the lever to the right increases the amount of dead resistance in series with the field winding, and this reduces the amount of current in that winding, thus reducing the strength of the magnet and consequently the e.m.f. at the brushes. The contrary movement of the lever, of course, has the opposite effect. Such an arrangement is called a "rheostat."

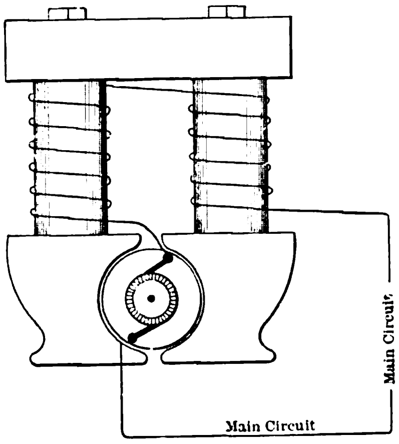


FIG. 1.—SERIES WINDING.

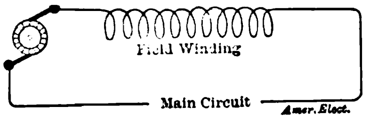


FIG. 1-a.—SERIES WINDING.

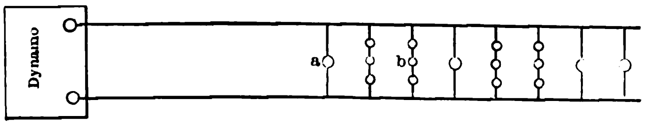


FIG. 4.

The lamps or other devices constituting the load on a constant-potential circuit are always connected in multiple or parallel, or else in series groups which are connected in parallel with each other and which constitute each a single constant-potential element and must be thrown in and out of circuit as such. Fig. 4 represents a constant-potential circuit having both single devices, *a*, and series groups, *b*. It will be evident that decreasing the load *increases* the resistance of it.

Series-wound dynamos are employed only when the load is of a character requiring an unchanging *current;* these machines are commonly referred to as "constant-current dynamos." Fig. 5 represents a series or constant-current circuit, the receptive devices being indicated by crosses. It is obvious that when one or more devices are removed from the circuit (the line being, of course, made continuous where the devices were taken out) the total resistance is *decreased;* without dynamo regulation, therefore, the current would increase to an excessive strength.

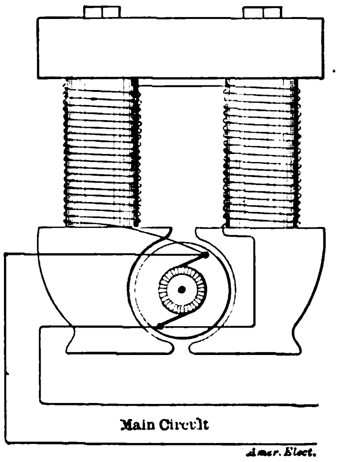


FIG. 2.—SHUNT WINDING.

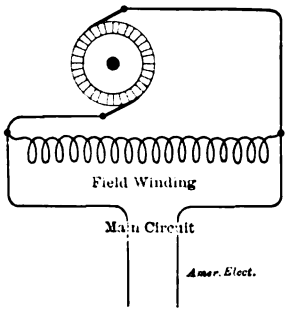


FIG. 2-a.—SHUNT WINDING.

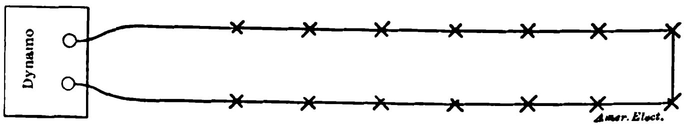


FIG. 5.

Series-wound dynamos are regulated to give a constant current strength, varying their e.m.f. according to the requirements of the load. One method of regulation consists of varying the field magnet strength by means of an adjustable resistance or rheostat connected in parallel with the field winding, as indicated in Fig. 6. This shunts a greater or lesser amount of current from the field winding, according to the amount of resistance made active by the lever, *L*. Thus, if the current in the armature and main circuit were 10 amperes, and the resistance of the field winding were 10 ohms, a resistance of 40 ohms in parallel with the winding would cause the current to split in the ratio of 40 to 10, or 4 to 1; 2 amperes would pass through the resistance and 8 amperes through the field winding. Another method of regulation consists of dividing the field winding up into sections and throwing the sections in and out of circuit. This is shown in Fig. 7. As the strength of any magnet depends on the number of ampere-turns in its magnetizing winding, reducing the number of turns will reduce the magnet strength, the current being kept constant. This method of regulation is objectionable, however, for magnets of large size, because of the tendency to flashing at the contacts of the regulating switch.

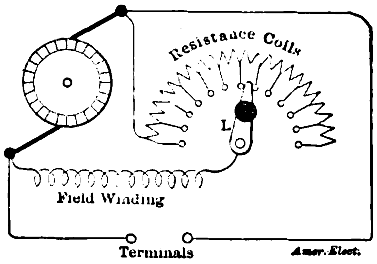


FIG. 3.—SHUNT FIELD REGULATION.

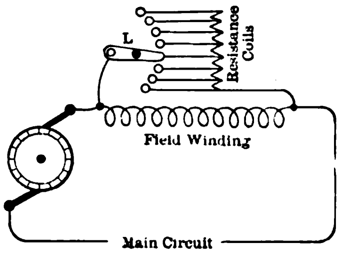


FIG. 6.—SERIES FIELD REGULATION.

It is impossible to supply a constant-potential load from a series-wound dynamo for the reason that a small load will not allow sufficient current to flow to fully magnetize the field magnet. Thus, a series-wound machine designed for 100 amperes and 115 volts would require a field-exciting current of 100 amperes in order to generate 115 volts. If the resistance of its own windings were 0.05 ohm, 5 volts would be used up in the windings at full load, leaving 110 volts for the load. So long as the resistance of the load and circuit wires remained at 11 ohms the machine would operate perfectly, but if the load were reduced until the resistance of the whole circuit became

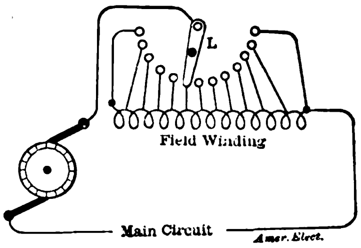


FIG. 7.—SECTIONAL SERIES WINDING.

22 ohms, the current would be reduced about one-half; this would reduce the field magnet strength, cutting down the e.m.f. and causing a further reduction in field magnet strength, and so on until the e.m.f. became reduced to a useless value.

The two fundamental windings just described are combined in two ways, the more common of which is illustrated diagrammatically by Figs. 8 and 8-a. The magnet is provided with both windings, the shunt winding serving to give the initial excitation and maintain the proper e.m.f. when there is no load. The series winding is connected so as to magnetize in the same direction as the shunt winding, and as soon as any current flows in the work circuit, it strengthens the field magnet so as to increase the e.m.f. of armature and compensate for voltage losses in the armature and series windings and also losses in the connecting wires between the dynamo and the load. The effect of the series winding may be adjusted by some such means as those shown in Figs. 6 and 7, so that the field is strengthened precisely enough, as the load is put on, to raise the generated e.m.f. by just the amount lost in the armature and other parts of the circuit, and thus keep the e.m.f. at the load unchanged. A rheostat is provided in the circuit of the shunt field winding to adjust the initial e.m.f. to the proper value. This arrangement of windings is called "compound" field windings, and the effect of the series coils is termed "compounding." The shunt-field circuit is sometimes connected across the brushes, as in Fig. 9, instead of in direct shunt to the load circuit, as in Fig. 8-a; one arrangement is practically as good as the other.

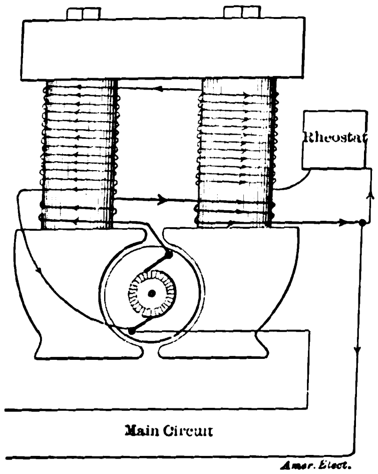


FIG. 8.—COMPOUND WINDING.

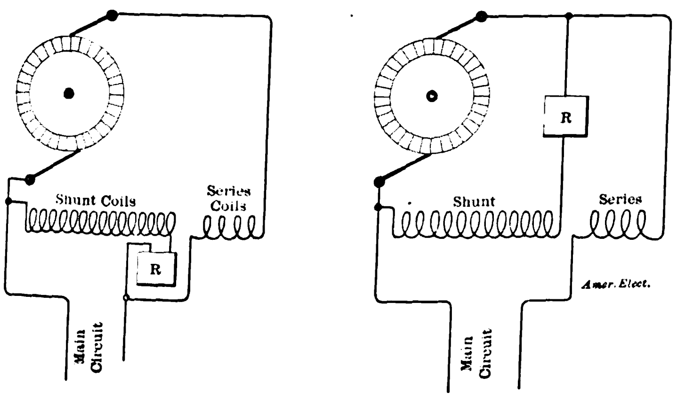


FIG. 8-a.—COMPOUND WINDINGS.—FIG. 9.

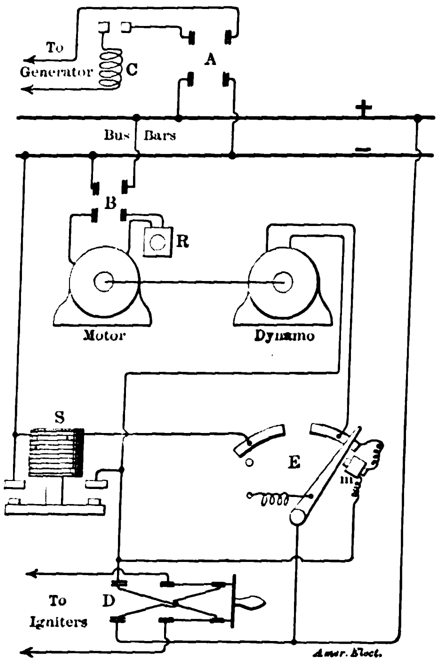
The other method of combining shunt and series field windings, referred to above, consists of putting both windings on the magnet and connecting them so that they oppose instead of assisting each other. The shunt winding usually gives the initial magnetization and the series winding partally neutralizes the effect of the shunt winding. When the current becomes excessive, the series coils weaken the field and reduce it. This action, of course, cannot be perfectly compensative, because some excess of current is necessary to make the series coils keep the voltage (and therefore the current) down. This arrangement has been tried on constant-current dynamos, but has never come into commercial use to any considerable extent.

Letters on Practical Subjects

A Motor-Dynamo Trouble.

To the Editor, American Electrician:

I shall be glad to have some of your readers enlighten me regarding the probable cause of an unusual action noticed recently in a 230-volt direct-current motor direct-connected to a 15-volt 100-ampere dynamo. The connections of the outfit are shown by the accompanying diagram. The motor takes current from a pair of bus-bars through an ordinary double-pole switch, *B*, and the bus-bars are supplied by a generator through a circuit-breaker, *C*, and a double-pole switch, *A*. The 15-volt dynamo, driven by the motor, is used to supply current to gas engine igniters. The connections between the dynamo end of the motor-generator set and the igniter leads are as shown in the diagram. The switch, *E*, is an automatic arrangement intended to transfer the igniter leads from the small dynamo to the bus-bars in case of a failure of the small machine. Should the motor-generator set break down, or have to be shut down for any cause, the cessation of current through the magnet, *m*, will allow the lever of the switch, *E*, to fly over to the left, connecting a high-resistance solenoid *S*, to the bus-bars. This draws up its plunger and connects the negative bus-bar to one of the igniter leads. The positive bus-bar is permanently connected to the other igniter lead. On the occasion referred to above, the circuit-breaker, *C*, opened and the motor, of course, came to a stop. I closed the circuit breaker, as I had done many times previously without first opening either the main switch, *A*, or the motor switch, *B*. When the voltage was nearly up at the bus-bars, I was startled by a vicious humming from the motor, and upon inspection found a ring of flame entirely encircling the commutator, and also found the armature revolving backwards at a very much higher speed than its normal rate. I immediately opened the switch, *B*, of course, when the armature came to a standstill. Upon closing *B* again and cutting out the armature resistance in the box, *R*, in the usual manner, the motor started up normally and ran as usual. I am under the impression that when the circuit-breaker was put in, the handle of the starting box, *R*, had not been released by the magnet, so that all of the resistance was cut out of the armature circuit.



MOTOR-DYNAMO CONNECTIONS.

Since writing the above I have noticed that this peculiar action invariably takes place if the motor is thrown in circuit with the arm of its starting box in the full "on" position.

CHAS. D. STOREY,

Iola, Kansas.

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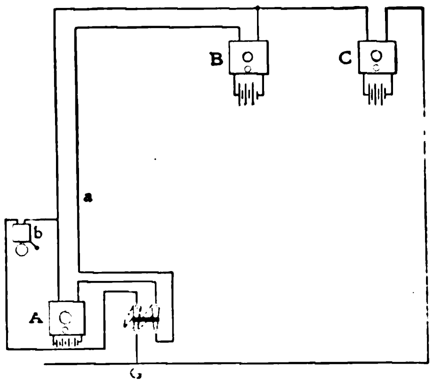
Solutions of Mr. Chase's Problem.

To the Editor, American Electrician:

The accompanying sketch is a diagram of the method of solving the problem in telephone connections which I sent you, and which was published in the May number of the AMERICAN ELECTRICIAN. I do not claim that this is the best possible solution but it has given satisfaction. The instruments were without relays, in which case they could have been connected in series. I installed a double-pole strap switch so arranged that when thrown to the right the straps were on the two contact buttons, as shown in the sketch, and when thrown to the left the right-hand strap came into contact with the left-hand button, as indicated by the dotted lines. The connections are practically self-explanatory. Station *C* uses one of the line wires and gas pipe for both ringing and talking, while Station *B* uses the two line wires. The double-pole switch is normally maintained in the position shown. In order to call Station *B* and converse with that station, the switch remains in this position, but for calling and conversing with Station *C*, the switch is thrown to the left, disconnecting the auxiliary bell and substituting the gas-pipe connection for that of the line wire, *a*. It is evident that with the switch in the position shown, if Station *B* calls Station *A*, the regular bell will ring, but if Station *C* calls Station *A*, the auxiliary bell will ring.



MR. CHASE'S SOLUTION.

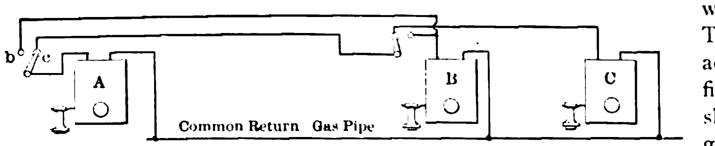
I have received the accompanying diagram (Fig. 2) as a solution of my problem from A. H. Lilley, Philadelphia, Pa. This solution has the advantage of requiring no auxiliary bell and no special switch, simply two two-point singe-pole switches. It is ingenious, but open to the disadvantages that Station *A* cannot call Station *C* if the switch at Station *B* happens to be left on the right-hand button, and this would likewise prevent Station *C* from calling Station *A*.

Haverhill, Mass. A. T. Chase.

[Mr. Lilley's solution is identical with that of Mr. Baskerville, published last month. Mr. Chase's letter was received before the June number of the paper was issued, but too late to appear in that number. —Editor.]

To the Editor, American Electrician:

Referring to the solutions of Mr. Chase's problem in telephone connections which were published in your June number, it occurs to me that Mr. Gobel's method of connections is rather complicated. As he uses magneto signaling apparatus it would seem that if Station *C* tried to call Station *A*, the bell at Station *B* would be rung through the extension bell, *E*, at Station *A*. Mr. Malcolm's solution is open to the disadvantage that when Station *C* calls Station *A*, both bells will ring, and the bell at *C*, being so much nearer its battery than the one at A, it would require considerable battery strength to ring the latter bell unless the bell at *C* were given a much greater resistance than the auxiliary bell at *A*. The same thing would happen if Station *A* called Station *C*, and there would be no privacy between the telephones. In Mr. Perry's solution, if Station *A* and Station *C* were talking, Station *B* could hear also. Mr. Baskerville's solution is a very good one, and seems to be the only one of the lot that would work without any trouble or disadvantage.



MR. LILLEY'S SOLUTION OF MR. CHASE'S PROBLEM.

Kearny, N. J. J. Siddall.

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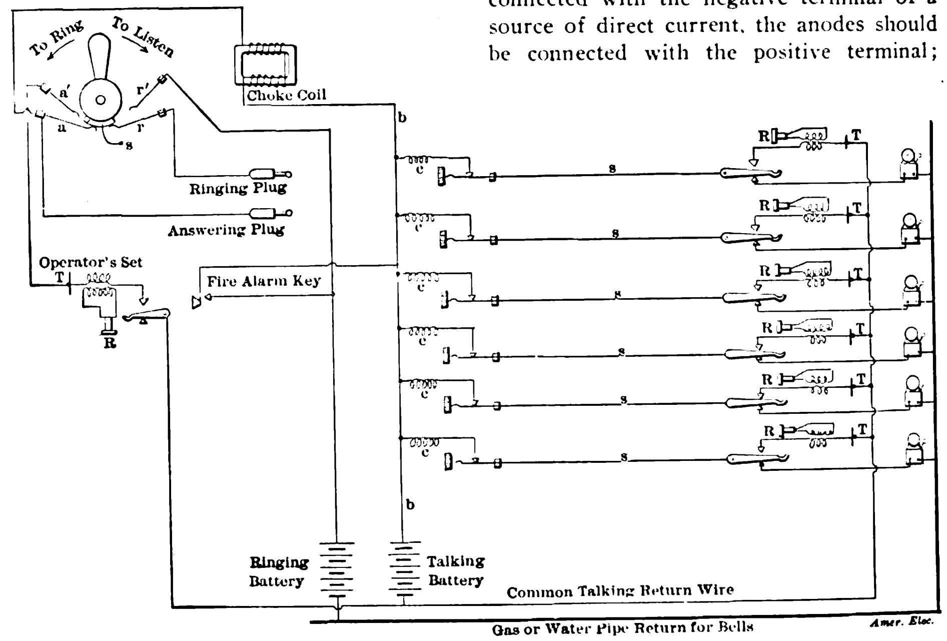
The Brown Interior Telephone System.

To the Editor, American Electrician:

In the April number of the American Electrician you published a description of a simple hotel telephone system devised by the writer. Since the original system was devised I have made some changes in it which I think constitute improvements. The accompanying diagram shows the later system. One difference between this and the original system is that the choke coil, which was formerly connected to the segment, *s*, on the ringing cam, is now connected to the spring *a*. The spring *a'* is set very close to the segment and the spring *r'* is set much further away. By this means it is possible for the operator to "listen in" through the ringing plug by tilting the listening key slightly, thus obviating the necessity of changing the plugs after ringing up a station. In answering a call the listening key is pushed all the way over of course, making the usual listening connection. The object in setting the spring, *r'* further away from the segment, *s*, than the spring, *a'* is set, is in order to avoid connecting the terminal of the choke coil to the ringing battery when the cam is thrown over to the left; otherwise all of the bells at the individual stations would be rung when the cam was tilted slightly. There has also been added to the system a fire-alarm key, as shown in the diagram; it will be evident upon inspection that depressing this key connects the ringing battery to all of the individual bells. I found it advantageous in practice to make the springs of the ringing and listening key all rather broad, and sprng. *a*, somewhat heavier than the others in order to reduce the resistance of the contact in the choke coil circuit.



BROWN INTERIOR TELEPHONE SYSTEM.

Percy M. Brown.

Toronto. Ontario, Canada.

Electrical Catechism

686. What arethe essential conditions for successful electroplating?

The surface to be coated must be perfectly clean; the electrolyte must be composed of the proper chemicals, and should be of the proper density and temperature; the anodes should be of the proper material, the object to be plated should be connected with the negative terminal of a source of direct current, the anodes should be connected with the positive terminal; both the object (the cathode) and the anodes should be immersed in the electrolyte and should be placed in suitable positions; the current should be adjusted to proper strength according to the surface of the work, and should operate for a suitable length of time, varying with the thickness of plating desired. For getting all these conditions right experience is the best teacher. The beginner can use the experience of others to some extent, but personal experience is essential for the best results.

687. Describe in general terms the process of electroplating?

The object which is to be given a coating of metal is carefully cleaned and polished so as to give a good surface for the coating. The object is then suspended in a solution of the metal to be deposited and current is sent through the solution into the object to be coated. The current breaks up the solution, deposits the metal on the object, and dissolves fresh metal from the anodes. The solution is generally held in a rectangular tank of some nonconducting material. On two or more sides of the tank, plates of metal are suspended by wires attached to rods which are electrically connected with the positive terminal of a suitable battery or dynamo; these are called anodes, since the current enters the bath through them. The object to be plated is suspended in the solution by wires attached to one or more rods which are electrically connected with the negative terminal of the battery or dynamo. An adjustable resistance is generally placed in the circuit for the purpose of regulating the strength of the current. The time required for depositing the coating varies from a few seconds to several hours or even days.

688. *What objects may be electroplated?*

A metallic coating can be deposited on anything whose surface is or can be made a conductor of electricity; thus, any metal surface can be plated. Surfaces of wood, plaster or other nonconductor may be rendered conducting by rubbing them with powered graphite or powdered metal so that the particles are in contact with each other and thus form a continuous coating. In some cases the object is wetted with a solution from which a metallic deposit is precipitated chemically.

689. *What metals are generally deposited in electroplating?*

The most common metals used are copper, nickel, silver and gold. Tin and zinc may be deposited on iron, the former making "tin" or tinned iron, and the latter "galvanized" iron. Most of the "tin" is coated by simple immersion in melted tin or in an alloy of tin and lead, while most of the galvanized iron is made by dipping iron sheets into melted zinc; some of the metal on the market is coated by electroplating. The other metals, such as iron, lead, aluminum and magnesium, and alloys, such as brass or bronze, can be deposited without excessive difficulty.

690. *How are articles cleaned for electroplating?*

The cleaning generally consists of two processes, a dipping in alkali to remove grease and a mechanical or chemical removal of the film of oxide that is almost invariably present, this being followed by a second dipping in alkali to remove any traces of grease received while cleaning from oxide. Most of the failures in electroplating come from imperfect cleaning of the work.

691. *How are iron or steel articles prepared for plating?*

The scale of oxide and sand can be loosened by soaking in a "pickle" composed of 1 part of sulphuric or of muriatic (hydrochloric) acid to 15 parts of water, being careful to add the acid to the water and not the water to the acid, so as to avoid vigorous boiling and spraying of the acid. The articles are then rubbed free from scale by a wire scratch-brush or are "rattled" in a tumbling barrel. The surfaces are then made smooth by an emery wheel or emery belt, beginning with coarse emery and gradually using a finer and finishing with pumice. Sometimes it is sufficient to scour with a brush and fine sand. The article is then dipped in hot potash water (half a pound of caustic potash to one gallon of water in a clean earthenware vessel) and is scoured with a stiff fibre brush and pumice to remove all traces of grease received during polishing; it is then dipped in hot water to remove the alkali and is then quickly transferred to the plating bath.

692. *How are brass or copper articles prepared for plating?*

They may be polished with fine emery or tripoli, finishing with tripoli or rouge. This is done most perfectly with leather wheels and buffs revolving at a peripheral speed of from 4500 to 7000 feet per minute. The wheel revolves so that the lower side leaves the workman, and the work is held against the lower side of the wheel for convenience and comfort.

After the articles have been polished, they are dipped in hot potash water and are scoured with fine pumice and a bristle brush; then rinsed in clean water, then in clean potash water, or in a cyanide dip, then in clean water and quickly transferred to the plating bath. The cyanide dip is made by dissolving half a pound of commercial cyanide of potassium in a gallon of water in a clean earthenware vessel. The cyanides are exceedingly poisonous and should be handled with great caution.

693. *How are large numbers of small articles cleaned cheaply?*

Small articles are often placed in a "tumbling barrel," which is a cylindrical box mounted on trunnions so that it may be revolved by belting or gearing. The articles are polished by rubbing against one another. When the articles are trinkets, sawdust is frequently added. Sometimes the articles are placed in a canvas bag with sawdust, and are shaken by two persons, or one end may be fastened to a post or wall.

694. *What sort of vessels are used for plating baths?*

Glass jars, such as used for storage batteries, are suitable for comparatively small work. Well glazed earthenware jars are often used for large work; enameled iron tanks or asphalt-lined wooden tanks are more commonly used for large work. The jars or tanks are generally square or oblong, rather than round, as a wider variety of work can be held. Enameled iron cooking utensils are suitable for small work, but care should be taken that there are no cracks in the enamel; white enamel is preferable to gray or blue. Similar vessels are used for holding the acids, pickles, etc. The plating tanks should be large enough to allow the anodes to be an inch or more from the nearest part of the work, and in nickel-plating the distance should be from three to six inches, or even more. The point is to have every part of the object plated at the same distance from the anodes, for the amount of metal deposited is proportional to the current at any part, and this is inversely proportional to the distance; if the anodes are a considerable distance from the work, the current spreads out evenly and gives an even deposit. If any part comes too close to an anode, the current is too strong at that point and the metal is deposited poorly, so that the work is "burnt."

695. *What are used for anodes in electroplating?*

The anode consists of one or more flat plates of the same metal as that deposited. When everything is working properly, the anode is dissolved, and exactly replaces the metal which is deposited from the solution, thus keeping the solution of proper strength. It is essential that the anodes be made of pure metal. For depositing brass, the anodes are sometimes brass and sometimes of separate copper and zinc plates, in the proportion desired. The anodes are hung around the sides and ends of the plating bath, and are electrically connected with the positive terminal of the battery or dynamo which furnishes the current. Sometimes, for short jobs, anodes of carbon or of platinum are used when no plates of the proper metal are at hand, since these two substances are dissolved very slowly, if at all.

696. *What copper should be used for the anode of a plating bath?*

Electrolytic copper is best, as it gives off copper more freely. The current should be carefully regulated and should be rather weak for working the solution given in answer to Q. 683.

697. *How are the plates arranged?*

In some cases the plates are arranged in series and in others in parallel. The former has the advantage of requiring the electrical contacts to be made to the first and last plates only, whereas the parallel plan requires connection to each plate. In the series arrangement, however, there is considerable leakage of current, which may amount to about 15 or 20 per cent.

698. *What voltage and current density are required?*

The voltage required is from 0.2 to 0.4 volt per cell with a current density of 10 to 15 amperes per square foot. It requires in practice 400 to 475 ampere-hours per pound of copper, the theoretical amount being 382.6 ampere-hours. About 8 or 9 pounds of copper are produced per kilowatt-hour at about 0.3 volt, which is the ordinary value.

699. *About what is the cost of refining copper electrolytically?*

The cost of the process is about seven-tenths of a cent per pound of copper. A great advantage of the electrolytic method of refining copper is the fact that the silver and gold contained in the copper are left behind in the sediment, from which they are extracted afterward, usually by electrolysis. The silver and gold thus recovered constitute an important item in the output of an electrolytic refinery, amounting to about $50 per ton of copper treated.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Why does the formula for the induction of electromotive force contain the factor 10^{-8}? E. P. W.

Because the practical unit of electromotive force is 100,000,000 times larger than the C. G. S., or fundamental unit.

If three transformers connected delta-fashion to a 1,000-volt primary line and having a ratio of 10 to 1 be connected Y-fashion at the secondaries, what will be the secondary voltage? (2) If the method of connection is reversed, putting the primaries in Y and the secondaries in delta, what would be the secondary voltage? R. S.

173 volts. (2) 57.7 volts.

Why cannot a series dynamo be used for incandescent lighting? R. E.

If the lamps are connected in series it can. You will find in the Lessons Department of this month an explanation of the reason why a series dynamo cannot be used for constant-potential circuits.

How can I give small articles of polished brass a dead black finish? T. B.

Make a strong solution of nitrate of silver and, in a separate dish, a solution of nitrate of copper. Mix the two together and plunge the brass into it. Next heat the brass evenly until the desired degree of dead blackness is obtained.

Why do large transformers have fewer turns of wire than small ones? D. E. C.

Because the counter e. m. f. of the transformer is the product of $\Phi \times t \times n$, in which Φ is the magnetic flux, t the number of turns, and n the frequency in cycles, and in large transformers the core is larger and consequently the magnetic flux is greater than in small ones, requiring a smaller number of turns for a given frequency and e. m. f.

Is it necessary to use a 250-volt 50-h.p. generator to run fifty 110-volt arc lights of 1,000 candle-power each? (2) Is it better to have a dynamo to run motors and another to run lights, or to run both motors and lights from the same machine? F. H. S.

It does not require a 50-h.p. generator to operate 50 arc lamps of 1000 nominal candle-power each, unless the 110-volt lamps are operated singly on the 250-volt circuit, which is very bad practice. If the lamps are operated in groups of two in series, they will take practically one-half the power, or perhaps a little less, that they require operated singly on the 110-volt circuit. (2) It is preferable to have a single dynamo to run motors and lights, provided the motors are of the ordinary type and are not started up frequently under full load. If the motors drive elevators or cranes, however, it is preferable to supply them from a separate source in order to avoid interference with the regulation of the lighting circuit.

How may I mark on steel or finished iron? I desire to obtain a substitute for chalk. C. M.

Try a piece of bluestone (copper sulphate). Wet the part you wish to mark, being careful not to grease it, and rub the bluestone over this. It will leave a copper-colored film which shows the scriber marks quite clearly.

How may I make a soldering liquid which is non-corrosive? A. J.

A soldering liquid which is claimed to possess the advantage over zinc chloride of not being corrosive or injurious to the health is made by dissolving one part each of lactic acid and glycerine in eight parts of water.

In a design of a 2-h. p. series motor for automobile work, operating on 30 volts and 50 amperes, how many circular mils per ampere should be allowed at normal load? (2) What would be a suitable value for air-gap density? L. W. M.

A fair figure for automobile motors is 1000 circular mils per ampere at normal load. (2) The air-gap density should be from 40,000 to 45,000 lines per square inch.

How much surface should I allow in a condenser for every pound of steam to be condensed? E. V.

Good American practice allows one square fot of surface in condensers for every ten pounds of steam to be condensed per hour, with a vacuum of 25 inches of mercury and an initial temperature of 75 degrees Fahr. from the cooling water. About 25 lbs. of water per pound of steam is allowed and the condensed steam is reduced to a temperature of about 120 degrees Fahr. This amounts to heating 25 pounds of circulating water from 75 degrees to 116 degrees Fahr. per 1.10 square foot of surface per hour with steam at 133 degrees Fahr.

What is the difference between the commercial efficiency, electrical efficiency and conversion efficiency of a dynamo? E. F. D.

The commercial efficiency is the ratio of the electrical power delivered by the machine to the mechanical power applied to its shaft. The electrical efficiency is the ratio of the electrical poower delivered to the total electrical power developed in the armature, which is the sum of the delivered power and that devoted to overcoming the resistance of the armature and field windings. The conversion efficiency of a machine is the ratio of the total electrical power developed to the mechanical power applied to the shaft.

How may one calculate the ampere-hours of ordinary commercial types of storage batteries? (2) Is there any standard rule applying to the rate of charge and discharge per square foot of positive surface? G. H. V.

There is no hard-and-fast rule by which the ampere hours of a storage battery can be determined. The capacity of a battery depends upon the type of plate used and upon the rate of discharge. (2) There is no fixed rate of charge or discharge per square foot of positive plate surface, as this again varies with the type of plate used. The only way to ascertain accurately the proper rate of charge and discharge, and the capacity of the battery in ampere-hours at different rates, is to consult the catalogue of the manufacturer who makes the battery.

What is the ratio between the alternating-current and direct-current voltages of a rotary converter? A. K. B.

In a two-phase rotary, the alternating-current, theoretically, is 0.707 of the direct-current voltage. In a three-phase machine the effective alternating-current voltage is, theoretically, 0.613 of the direct-current voltage. In practice, however, the ratios vary considerably, on account of variations in the electromotive force curve.

How does aluminum compare with copper for electrical purposes? E. M.

Aluminum of average commercial purity (99.55 per cent) has an electrical conductivity of about 61 per cent of commercially pure copper of equal section, so that an aluminum wire having an electrical conductivity equal to a copper wire has a square area of section in the ratio of 1.64 to 1, and a diameter of 1.28 to 1. The weight of aluminum for equal conductivity is .485 to 1. The tensile strength for equal section bears the ratio of .46 to 1, and the tensile strength for equal conductivity is .75 to 1.

What is the compression space of a gas engine? (2) What is meant by the compression ratio? (3) Why is the pressure within the cylinder of a gas engine during the charging stroke below atmospheric pressure? (4) What is the formula for the horse-power of a gas engine? L. G.

All the space that is behind the piston when the crank is on the inner center. (2) The total volume of the cylinder and compression space (measured with the crank on the outer center) divided by the volume of the compression space. (3) Because the ports and passageways are usually too small to allow the mixture of gas and air to enter rapidly enough to prevent the production of a partial vacuum. (4) There is no formula that is of any practical value. There has been a number of empirical formulas prepared, but all of these give the barest approximations.

What is the time constant of a circuit? (2) Is conductance the opposite of resistance, and, if so, is not susceptance the opposite of reactance? (3) What is resonance? A. A. A.

The time constant is a measure of the rate at which the current in an inductive circuit reaches its maximum value when a constant e. m. f. is first applied to the circuit. The time constant is equal to $\frac{L}{R}$, L being the inductance or coefficient of self-induction, and R the resistance. (2) Conductance and susceptance are respectively the "opposites" of resistance and reactance in a general sense, but they are not reciprocals. In a direct-current circuit, conductance is the reciprocal of resistance, or $\frac{1}{R}$, but this does not hold good for inductive alternating-current circuits. Susceptance would be the reciprocal of reactance, or $\frac{1}{X}$, if it were possible to have a circuit with absolutely no resistance, but as this is impossible, susceptance and reactance are never reciprocals of each other. (3) When the reactance and capacitance of a circuit exactly balance each other, the circuit is said to be in a state of resonance.

ELECTRICALLY DRIVEN COAL-HANDLING PLANT.

A skilful solution of the problem of handling coal and ashes in a large power station is presented in the equipment of the new Pratt Street station of the United Railways & Electric Company, at Baltimore, Md. The boiler plant is rated at 16,000 horse-power, and the coal-storage bins, which are located above the boilers, have a capacity of 6000 tons; each bin is 32 ft. wide, 34 ft. deep and 128 ft. long.

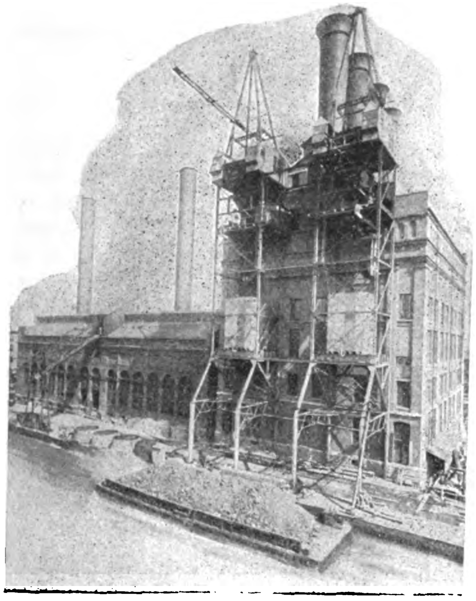


FIG. 1.—COAL HOISTING TOWERS AT PRATT STREET STATION.

The arrangement of the plant necessitates raising the coal to a great height, which, together with the large fuel consumption, made the conditions most exacting. The coal-hoisting towers and machinery were designed and constructed by the C. W. Hunt Company, New York, while the arrangement of the electrical apparatus in the tower is due to P. O. Keilholtz, consulting engineer of the United Railways & Electric Company.

On the east side of the boiler house, two steel towers were built for hoisting the coal, one of which has been equipped throughout while work on a duplicate equipment is in progress. This plant has the double distinction of having the highest hoist of any power station and being the only one of its kind equipped throughout with electrically-operated hoisting and conveying machinery. Each of the coal-hoisting towers is 183 feet high, and horizontal booms 52 feet in length extend over the water. A one-ton shovel is lowered by means of a cable passing over a truck which runs back and forth on the booms to the shovel below. The shovel hoist and boom truck are driven by electric motors geared to the drums.

From the railway switchboard, in the adjoining engine-room, a 550-volt main extends into the coal hoisting towers. On the first floor of the tower is a motor-generator set, the two members of which are of standard General Electric type. From the motor shaft the coal crusher is also driven. The function of the generator of this set is to supply current of suitable voltage to the hoisting motor on the fourth floor above, which raises and lowers the shovel. As the turning effort is transmitted through gears to the hoisting drums, it is essential that the motor be not subjected to violent starts by a sudden application of power. The mechanism is such that the rate of acceleration is even, and dependent upon the will of the operator.

When the shovel descends to the coal in the barge, the hoisting motor is started and closes the shovel, fills it with coal, hoists it loaded 151 feet over the tower, and dumps the coal into a hopper at the front of the tower on the engine platform. The shovel is then lowered open to the coal for another trip. An engineer and assistant regulate the operation of the hoisting machinery from the second platform in the tower, the former controlling the hoisting drum motor and regulating the speed and direction of rotation; the latter controls the motor hoist actuating the trolley on the boom. The shovel does not twist in hoisting or lowering, notwithstanding the great height of the hoist. The coal passes from the hopper through a Hunt coal cracker, where the large lumps are broken to the proper size for automatic stokers. By means of a double-jawed cut-off valve, the coal is fed into a Hunt automatic railway car, and it is then weighed. After the car is pushed off the scales, it passes to an inclined track over the bins, and is automatically discharged by a stop previously located at the point where the coal is needed. The energy developed by the loaded car on the incline is stored in a counter-weight which, when the load is dumped, returns the car to the scale for another load.

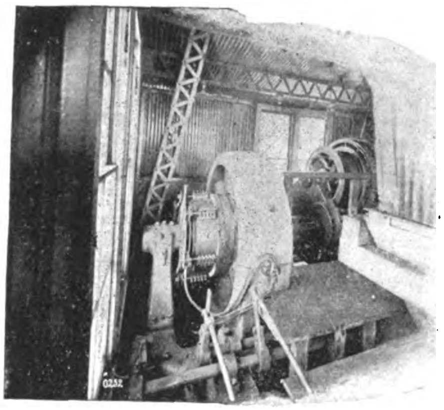


FIG. 2.—HOISTING DRUMS AND MOTOR.

The tower has a capacity of 50 tons of coal an hour, but recent records show that the hoist will deliver considerably more coal than the rated capacity. While the consumption of coal in a station of this size would probably be 100,000 tons per year, the coal handling plant has a capacity of ten times that quantity of fuel taken from the boat and delivered to the storage bins.

Under each of the boilers is an ash hopper from which a Hunt noiseless gravity bucket conveyor receives the ashes which descend into and are removed from the hoppers by gravity. The ashes are carried over the coal pockets and dumped into a chute leading into ash bins in the tower, from whence they are removed by car or boat. This conveyor is 430 feet long, with a vertical lift of 86 feet and is motor driven. When carrying a load of ashes, it requires but five horse-power to keep it moving. No shoveling or manual labor of any kind is required in receiving, transporting or delivering coal or ashes by this plant; the machinery is as nearly automatic in its operation as possible.

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EFFECT OF USING A VALVE LARGER THAN REQUIRED.

A practical demonstration of the adverse effect of installing too large a valve in high-pressure steam service was furnished recently in a Chicago Electric Station. A two-inch class "W" pressure regulator was ordered from the Foster Engineering Company, of Newark, N. J. It was placed on a two-inch pipe containing a boiler pressure of 150 lbs. The delivery pressure was to be reduced to 15 lbs. For delivery of the steam the valve was opened but two or three one-thousandths of an inch. There was about 150 feet of 2-inch pipe between the boiler and the valve which was not covered, consequently the steam was highly saturated when delivered. When passing through the valve the velocity of the steam was so high that it produced some drawing as shown by the accompanying illustration (Fig. 1.) This photograph was made after the valve had been in service but four months. The cause of the erosion was at once apparent and a valve exactly one-half the size was installed. This one-inch valve has been doing good service for two years and is still in operation.

The substantial design of the clapper before it was affected is shown in Fig. 2. The composition used was 88 per cent copper, 10 per cent tin and 2 per cent zinc.

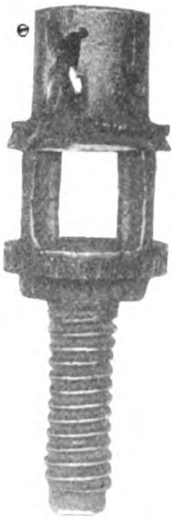


FIG. 1.

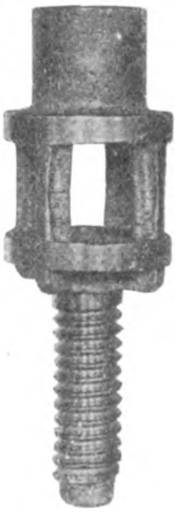


FIG. 2.

It has been found that while the erosion is not always as marked as in this instance, the cause of leaky valves may frequently be traced to the installation of a size larger than is necessary.

New Apparatus and Appliances

ELECTRIC HAND FAN.

A novel and unique little member of the fan line, recently placed on the market, is the fan manufacturedby the Cyclone Electric Hand Fan Company, of Philadelphia. The size of the article is but 6 inches, and it weighs a trifle over a pound. Fig. 1 shows the fan complete. It is made to run in series with a 110-volt lamp on either direct or alternating current, or directly from a battery of three storage cells. The fan is especially useful for barbers, hair dressers, dentists, hospitals, etc., or in sleeping rooms, as it does not create such a draft as the larger electric fans, and is much more portable. The fan is said to be practically noiseless in operation.

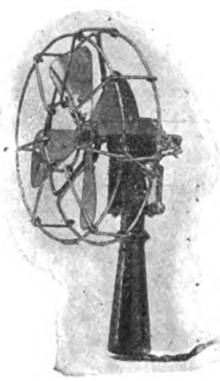


FIG. 1.—ELECTRIC HAND FAN.

A UNIVERSAL ROTATOR FOR PHOTOMETERS.

The accompanying engraving, Fig. 2, illustrates a new and universal rotator which has been brought out by Queen & Company, Philadelphia, Pa. As the illustration shows, the old method of rotating the lamp by means of a belt and pulleys is superseded by a small flexible shaft housed within the curved tube below the lamp socket, the other end of this shaft terminating in a friction roller which bears on the face of the driving disc. The friction roller is adjustable toward and away from the center of the driving disc, so that the speed of rotation the speed of the mechanism from which the driving power is derived. Another feature of the attachment is that the may be accurately adjusted irrespective of height of the socket can be changed in order to bring the center of the lamp filament in the correct horizontal plane. Connections are made to the lamp through collector rings on the bottom of the socket and brushes attached to the supporting frame, as usual, but instead of the customary flexible cords leading from the brushes two wires are carried to two brass rings on the back of the scale plate and additional brushes make contact with these rings. This arrangement allows the lamp-holding frame to be tilted to any desired angle about the horizontal axis without entailing the use of flexible cords. The attachment is designed to fit on either the Queen Reichsanstalt bar or the company's standard photometer frame for electric light and power stations.

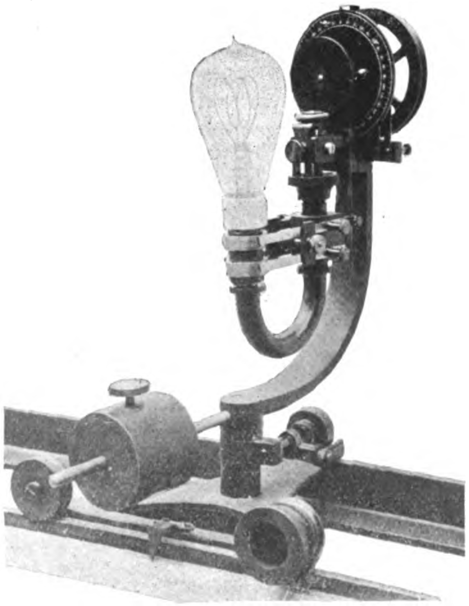


FIG. 2.—ROTATOR FOR PHOTOMETERS.

WESTINGHOUSE TYPE "N" TRANSFORMER.

The Westinghouse Electric & Manufacturing Company has made an advance in the direction of multivoltage transformer windings, and is now building a transformer provided with additional ratios of transformation, giving a greatly extended range of voltage; this is known as "Type N." As shown by Fig. 3, herewith, the shell type of construction used in Westinghouse transformers prevails. The primary winding of the "Type N" transformer is divided into equal parts, which may be connected in either series or multiple. The secondary winding is divided into four equal parts, which may be connected in series, series-multiplt or multiple. The primaries of all the transformers are nominally wound for 1000 and 2000 volts, and the transformers from ½ to 25 kilowatts inclusive are wound for nominal secondary voltages of 50, 100 and 200; those from 2 to 50 kilowatts inclusive are wound for voltages of 100, 200 and 400. The secondary voltage in each class of transformers can be varied to suit either the varying line voltage of an extensive transmission system, or to give special voltages from standard circuits. All transformers are arranged for three-wire secondary distribution, and the secondary coils are cross-connected to give equal voltages on both circuits even with largely unbalanced loads.

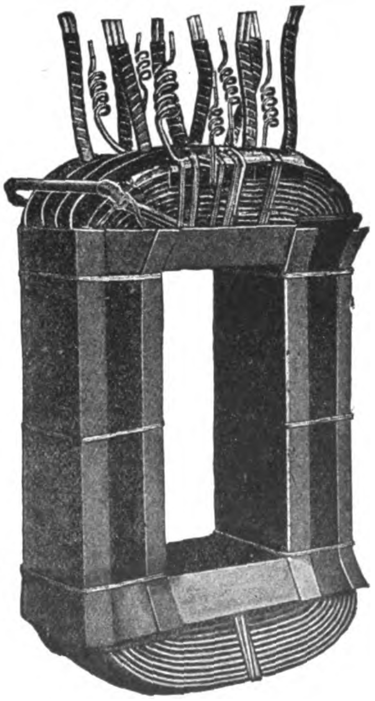


FIG. 3.—ASSEMBLED COILS SHOWING SPREAD ENDS.

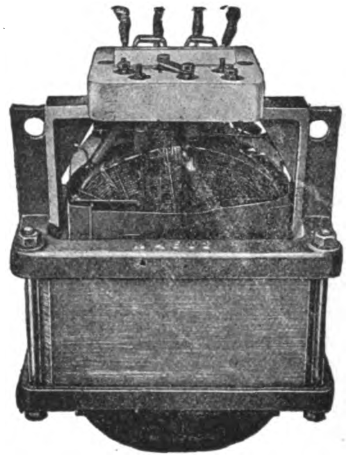


FIG. 4.—TRANSFORMER WITHOUT CASE.

ELECTRIC CONDUIT BENDER.

Fig. 5, herewith, shows an appliance made by W. W. Benson & Co., of Philadelphia, for bending lined and unlined electric conduit. The device is made of cast iron, in one piece, and has no levers, clamps, or movable parts. The design shown is adapted for use with five commercial sizes of electric conduit, namely: ½-in., ¾-in., 1-in., 1¼-in. and 1½-in., which is sufficient for ordinary work bent without heating. The dimensions of the appliance are: extreme width of base, 14 ins.; extreme length, 12 ins., and extreme height, 6 ins.; the weight is about 100 lbs. The curved surfaces of the device in which the pipe is engaged in bending are said to be the result of long experience and experiment. No bulging of the conduit at the sides or flattening at the top is said to be possible. In making long or short elbows, the length of conduit is pushed in the proper

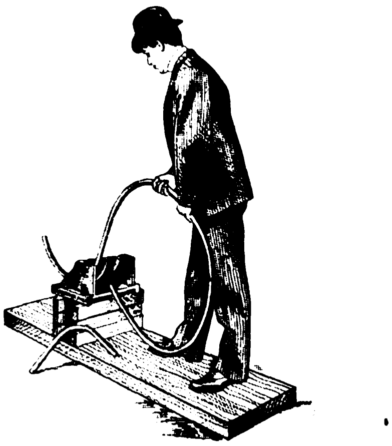


FIG. 5.—CONDUIT BENDER.

hole in the direction from back to front as far as desired. The conduit is then lifted from the back with one stroke for a short curve, or with several short strokes for a long curve of large radius. In making offsets, any that are not possible with the conduit pushed through the bender from the back, can be readily handled from the front. A three-inch extension on the base of the bender in front may be used as a heel to bear down on in making offsets or strengthening curves. Extremely short elbows can be made from the front.

THE HANCHETT-SAGE OHMMETER.

It is probably not generally appreciated that this otherwise well-known resistance measuring instrument can be used for making many tests which are not within the range of an ordinary Wheatstone bridge. They are so nearly absolutely non-conductive that it is feasible to use alternating current instead of battery power without introducing any appreciable error, and this of course, enables such work as measurement of inductance and capacity and the resistance of electrolytes to be accomplished.

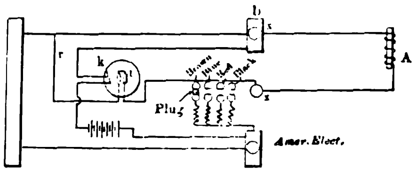


FIG. 6.—OHMMETER CONNECTIONS.

The subjoined seven figures show various methods of connection. Fig 7 shows how an ordinary resistance is connected to the ohmmeter when it is desired to measure its value in ohms. Fig. 6 shows the complete scheme of connection of the ohmmeter.

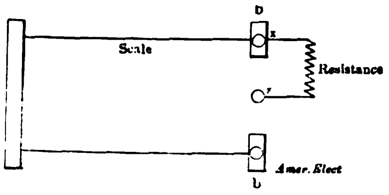


FIG. 7.—MEASURING RESISTANCE.

Fig. 8 shows how inductances are compared, *A* being the unknown resistance and *B* a coil whose inductance is known. Fig. 9, how the resistance of an electrolyte is measured. It will be noted that this is connected in the same way that an ordinary resistance is attached but that the alternating current obtained from the secondary of an induction coil is used instead of the direct current ordinarily furnished by the batteries contained in the instrument. Fig. 10 shows how crosses on lines may be determined by the ordinary loop test, and Fig. 11, the location of grounds in a similar way.

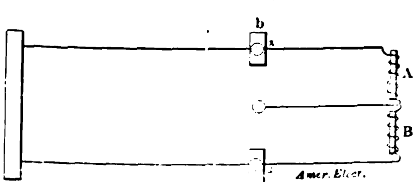


FIG. 8.—MEASURING INDUCTANCE.

In Fig. 12 are shown the connections for measuring capacity; *C'* being a standard condenser and *C* the unknown capacity. In this case as in Fig 9, an alternating current is employed in place of the direct current. The length of the scale of the ohmmeter on which the resistances are read off is 30 inches. As the scale of an ordinary portable volt or ammeter is but 5 inches long, some idea can be had of the fineness of readings obtainable. Machado & Roller, of 203 Broadway, New York, the general selling agents for the Whitney Electrical Instrument Company, have arranged for the exclusive manufacturing and selling rights of this convenient instrument.

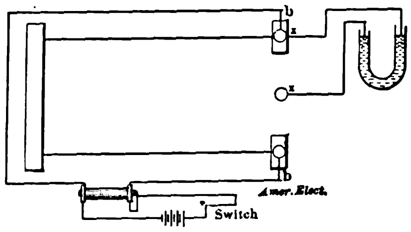
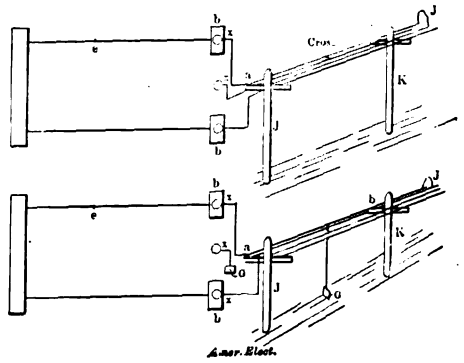


FIG. 9.—RESISTANCE OF ELECTROLYTE.



FIGS. 10 AND 11.—CROSS AND GROUND TESTS.

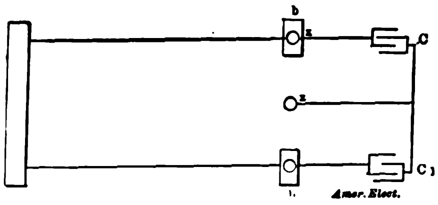


FIG. 12.—CAPACITY TEST.

HEANY ENCLOSED ARC LAMP.

A lamp which, it is claimed, combines with economy of operation and capacity for superior service, simplicity of construction, low cost and small size, is shown by Fig. 13, herewith. The lamp is the invention of J. A. Heany, and is marketed by the American Electrical Manufacturing Company, of Philadelphia. The construction is as follows: The lamp body, or frame, is composed of three tubes, which are held at the top by a casting and at the bottom of the lamp by a stamping. The solenoidal coil, which is small and powerful, is held and adjustably supported by the three tubes, provision being made to elevate or lower the coil on the tubes in order to adjust the lamp for the amount of current it is to take, or in orderthat any desired current consumption may be obtained without changing the resistance in the lamp. Extending from the top of the lamp to the base, and without the supporting tubes, is placed another tube, which receives the upper carbon and also the flexible bend and holder. This arrangement is said to insure a perfect contact and to prevent arcing. Surrounding this carbon-carrying tube is a combined solenoid core and clutch, consisting of two semi-tubular members pivoted or hinged together, and arranged to slide up and down on the carbon-containing tube. Each of the semi-tubular members is provided with extensions having projections adapted to engage or grip, and to make contact with the upper carbon. When the solenoid is energized the semi-tubular members are said to act as like poles and to repel each other, thereby throwing the extension with the jaws inward. The carbon is gripped and at the same time lifted, striking the arc. At the base of the lamp and supporting the carbon-receiving tube, is a tapered piece,which acts as a spreading device for the core. After the carbons begin to be consumed and the lamp feeds, the jaws of the solenoid core and clutch in their descent come in contact with the tapered piece, and are compelled to open so as to positively bring the jaws out of engagement with the carbon and free it. The solenoid is wound with about ¾-lb. of No. 16 bare wire. with asbestos cord between

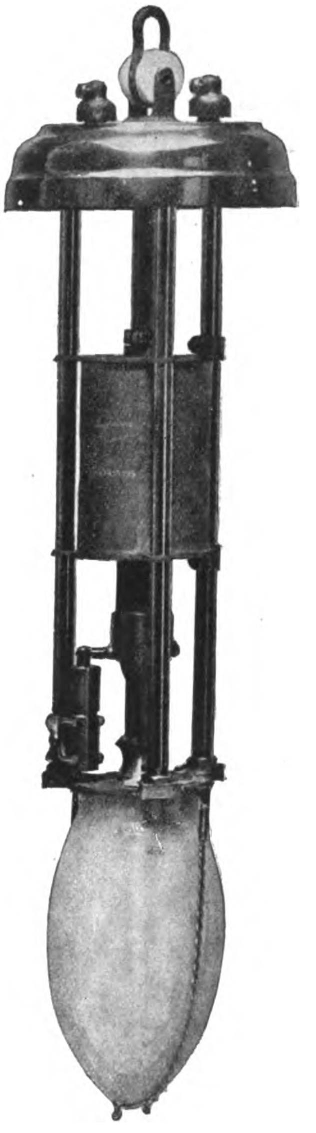


FIG. 13.—HEANY ENCLOSED ARC LAMP.

each two adjoining wires and a sheet of asbestos between two successive layers. This is said to make it possible to short-circuit the lamp without burning out the coil. Around the coil is placed a shell of soft iron to serve as a return for the magnetic circuit. The few parts of the lamp reduce the weight to less than six pounds, and as there are but two movable parts, the possibility of the lamp sticking is reduced to a minimum. The mechanical clutch is eliminated, a combined clutch and core operated by magnetism taking its place. Connected to the hinge portion of the core is a projecting arm pivoted to the dash-pot, which is secured with a clamp to one of the supporting rods of the coil. The voltage recommended for use on the lamp is from 75 to 80 volts. The amperage consumption may be varied between the limits of two and six amperes by sliding the solenoid coil up or down. Lowering the coil makes the current greater, and raising the coil has, of course, the contrary effect. The life of the carbon, when 7-16-in. carbons are used, is 150 hours, and on a 110-volt direct-current circuit a great advantage is obtained by using 7-16-in. carbons instead of ½-in., due to the fact that the surface is smaller, so that there is less conduction of heat; the result being that the carbon tips are heated to a much higher degree of incandescence.

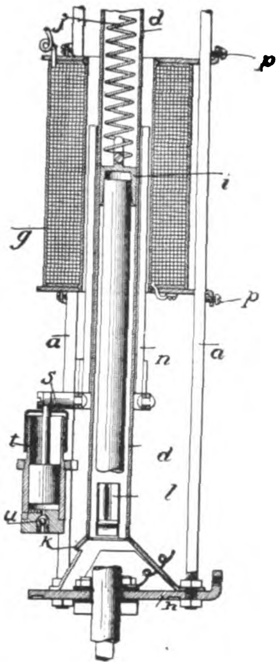


FIG. 14.—LAMP MECHANISM.

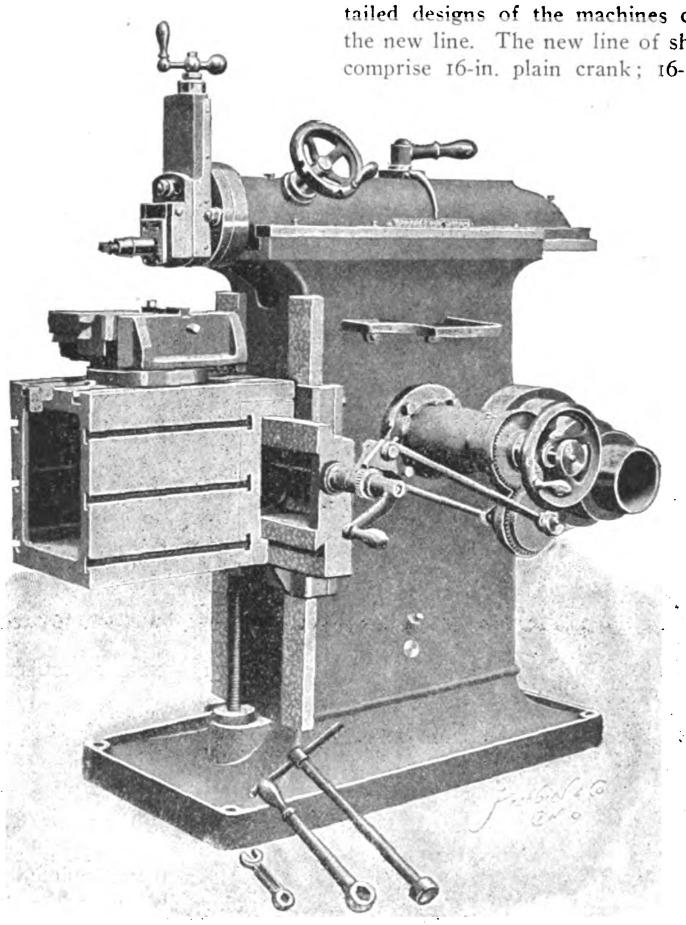


FIG. 15.—BACK-GEARED CRANK SHAPER.

A NEW SHAPER.

A recent disastrous fire in a Cincinnati foundry resulted in the complete destruction of all patterns covering the line of shapers manufactured by the American Tool Works Company, of that city. Profiting by an extensive experience in the requirements of the trade, the company took advantage of this opportunity to effect a number of radical changes in the sizes as well as the detailed designs of the machines comprising the new line. The new line of shapers will comprise 16-in. plain crank; 16-in., 18-in., 21-in. and 25-in. back geared crank, and 26-in. and 30-in. triple geared machines. The first of these to be brought to completion are the 16-in. plain crank and the 16-in. back-geared crank shapers; one of the latter is shown by Fig. 15. This shaper is heavier and stronger in every way than its predecessor. The column, base, ram, table, and so on, have all been made of greater dimensions and weight, thus giving additional power and capacity to the machine, yet retaining its graceful, well-proportioned, compact appearance. The stroke is positive and has five rates of speed. Its length may be changed at will without stopping the machine, and the index shown in the engraving facilitates the setting of the stroke to the length desired. The rocker arm is pivoted near the base line, and this gives the ram an almost uniform rate of speed its entire stroke, and provides an exceedingly quick return. The rocker arm is of double section, permitting a 2½-in. shaft to be passed under the ram through the hole shown in the top of the column for key-seating. This machine is said to be susceptible of fine and positive adjustments while in full operation, rendering it especially adaptable to tool room work.

THE KELLOGG RINGER.

In the accompanying illustration is shown a new ringer recently placed upon the market by the Kellogg Switchboard & Supply Company, and which is a decided novelty to the telephone public. The methods heretofore used of obtaining the proper adjustment of the armature of the ringer have, it is claimed, been crude. The armatures have been adjusted by various means, either by a screwdriver, wrench, or perhaps a hammer, to approach or recede from the pole pieces in order to make the ringer more or less sensitive. This new ringer embodies the decidedly new feature of letting the armature remain in its place, and causing the pole pieces to move forward or from it when the adjustment is made. Screw extensions are placed in the end of each core, which may be readily moved toward or from the armature by an ordinary wrench, and afterwards locked in place by a locknut, both of which are shown in Fig. 16. This makes a very simple form of adjustment, which is not only substantial, but delicate. The ringer has been made self-contained. The gong posts are mounted

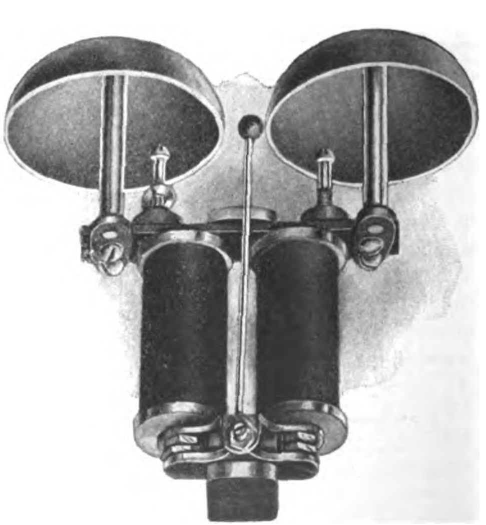


FIG. 16.—TELEPHONE BELL.

on the same frame as the ringer magnets, and no dependence need be placed on wood screws entering the lids of the generator box for maintaining the adjustment of the gong.

IRON ARMORED CONDUIT.

Fig. 19 shows a piece of iron-armored electric wire conduit made by the American Conduit Manufacturing Company, of New Kensington, Pa. The conduit is said to be non-conducting, acid and rust proof, and also to be immune from the effects of sulphurated water. The company manufactures conduit tubing for interior and exterior use, which it claims will bend without cracking or blistering. The points of advantage claimed for the "American" conduit are that it is elastic, has threads and couplings that fit and do not form a slip joint, and being machine made, are of uniform curvature and long radii and round in section.

ELECTRIC GLUE POT.

Fig. 17 shows the Detroit electric glue pot, which is the latest pot made by the United Electric Heating Company, of Detroit, Mich. The pot is made of cast iron throughout, and is plain and substantial, with a view to standing hard usage. A number of entirely new features are embodied in the pot, such as an enclosed self-contained switch, slow-changing water level and the absence of surface contacts or connections. The heating coil is so placed that the glue will heat to the proper consistency very quickly without rendering the pot liable to burn out. The advantages claimed for this pot are that it will not dent or break, requires less refilling than the ordinary pot, heats more quickly, and is free from all danger of short-circuit or disarrangement of parts.

FIG. 19.—IRON INTERIOR CONDUIT.

FIG. 17.—GLUE-POT.

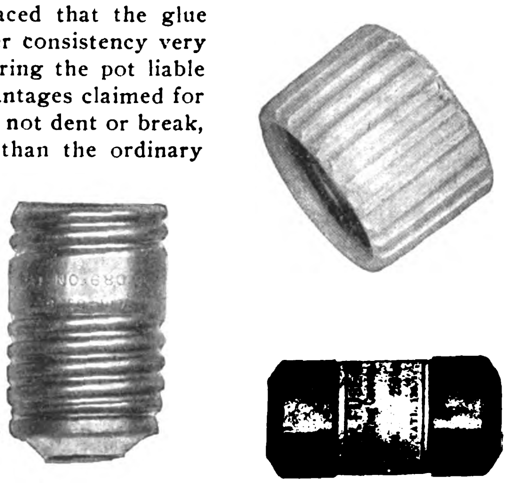


FIG. 18.—FUSE-PLUG.

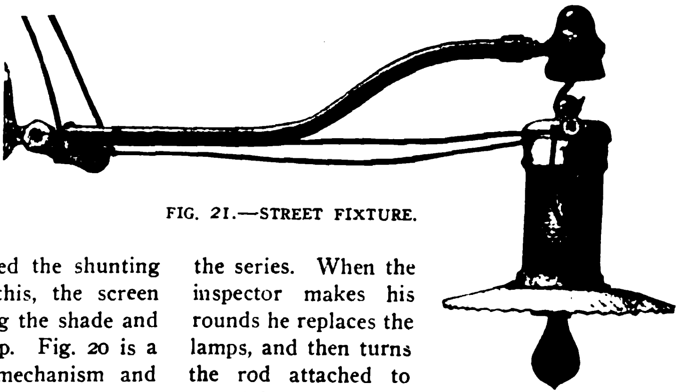


FIG. 21.—STREET FIXTURE.

250-VOLT FUSE PLUG.

The D. & W. Fuse Company, Providence, R. I., has recently placed upon the market an improved form of 250-volt fuse plug to fit the standard Edison cutout. The company had on the market a fuse plug operating on 250 volts, but the new plug which they are now turning out is considered a decided improvement over it. Fig. 18 shows the plug in its several parts, consisting of the casing, porcelain cap and small cartridge which contains the fuse proper. All that is necessary to recharge one of these is to remove the burnt out cartridge and insert a new one, an operation which requires but a few minutes. This company supplies cartridges which are all interchangeable in capacities from 3 to 30 amperes. This little device is said to have been recently subjected to a most severe trial, being directly short-circuited across a 250-volt circuit within ten feet of the switchboard of a very large central station having a capacity of between 4,000 and 5,000 kilowatts. They are said to have repeatedly operated with absolute freedom from flash, noise, or discharge of any kind; and later were short-circuited directly across a 440-volt circuit under the same conditions, where they operated satisfactorily, the only difference being that there was a slight noise at the instant of rupture of the fuse.

SERIES INCANDESCENT LAMP FIXTURE.

Among the numerous systems of series incandescent street lighting is the Auto-electric shunt system, illustrated herewith. Though not very generally known, the system is employed by a large company operating in the neighborhood of 5000 series incandescent lamps over a district of 17 miles in one direction and 9 miles in another. It will be noted that the arrangement of lamps on the fixture, as shown by Fig. 21, is a radical departure from any of the older methods. Two lamps are used on each fixture, one above the other, the upper lamp being protected from stray missiles by a screen. In the casting which forms the top of the lamp fixture is placed the shunting device. Directly beneath this, the screen is fastened, from which hang the shade and receptacle for the main lamp. Fig. 20 is a diagram of the shunting mechanism and connections. A very thin silk ribbon is wound upon two spools and passes over a metal roller, shown in the center of the diagram. The left-hand lead from the upper lamp is connected permanently to this metal roller and two contact fingers press lightly upon the silk ribbon where the latter passes over the roller. When things are in their normal condition, the lower, or main, lamp is simply in series with the other lamps in the circuit. Should the lamp break, however, the silk ribbon between the metal roller and the contact finger on the left is subjected to the full potential of the circuit and is punctured at that point, allowing the finger to come in contact with the roller and thereby completing the circuit through the upper lamp. Should this lamp also burn out, the ribbon is punctured under the right-hand contact finger, and the circuit is closed through the contact stud, and continues to operate with one lamp short in the series. When the inspector makes his rounds he replaces the lamps, and then turns the rod attached to the right-hand spool, winding up a portion of the ribbon sufficient to clear the punctures, when things are again in their normal condition. The system may be operated on any voltage, and is very flexible in that different series of lamps of different candle-powers may be used with the same shunt and fed from the same primary feeders. The system, moreover, possesses the obvious advantage of being immune from dead resistances or magnetic appliances requiring current in their operation and entailing loss; the only loss being that of transmission. The Auto

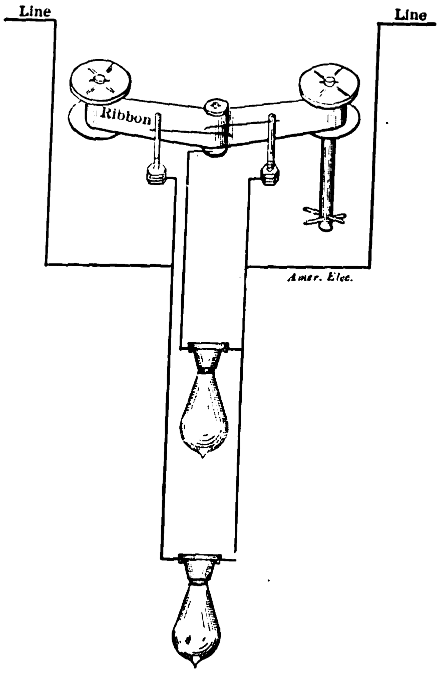


FIG. 20.—CUT-OUT CONNECTIONS.

Electric Shunt Company, of West New Brighton, Staten Island, N. Y., is the maker of these shunts and fixtures.

WESTON DUPLEX INSTRUMENTS.

Fig. 22 shows a combined voltmeter and ammeter made by the Weston Electrical Instrument Company, Newark, N. J., which for many purposes will be found much more useful than two instruments in separate cases. For instance, the close proximity of both scales and indexes permits of practically simultaneous readings of current and potential difference. The instruments were originally designed for automobile service, and care was exercised in their design and construction in order to meet the severe demands imposed by continuous rough service on the road, and to bear without injury the constant vibration to which such instruments are subjected while in use on vehicles. Aside from their adaptability to use on vehicles, however, the instruments are also well adapted for use in all other cases where extreme vibration is met with, or where space is very limited.

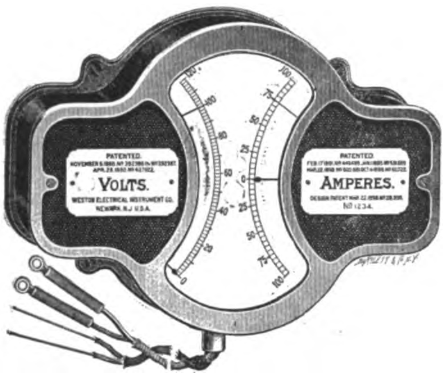


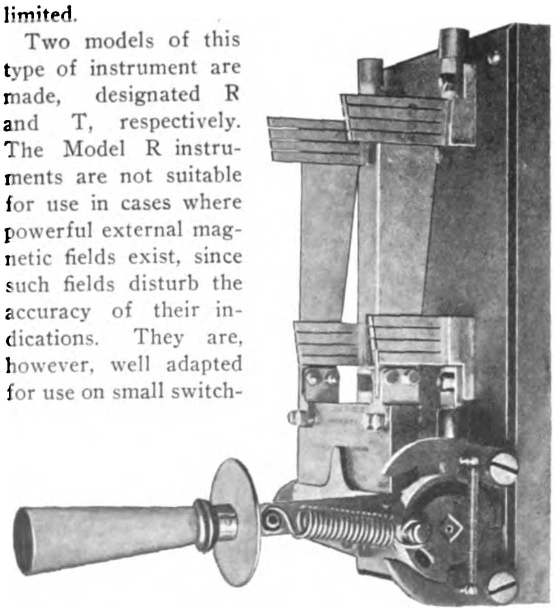
FIG. 22.—DUPLEX INSTRUMENT.

Two models of this type of instrument are made, designated R and T, respectively. The Model R instruments are not suitable for use in cases where powerful external magnetic fields exist, since such fields disturb the accuracy of their indications. They are, however, well adapted for use on small switchboards, and especially on motor-starter switchboards, where they will be found to render valuable service in indicating the power used in driving single machines or a group of machines. The only difference between the Model T and the Model R instruments is that the case is made of cast-iron and not water-proof; while the case of the Model R is made water-proof and of aluminum, and closely surrounds the operative parts of the instrument. The scale of the Model T is also larger than the scale of the Model R.

The Model T instrument is adapted for small isolated plants and for cases where the existence of powerful external fields would render it impossible to use the Model R, the cast-iron case of the former shielding the instrument from external fields in a most effective manner. The instruments are in all other respects similar, the bearings being made of highly polished sapphire, the pivots hard and accurately ground and polished.

QUICK MAKE-AND-BREAK SWITCHES.

Figs. 24 and 25, herewith, show two forms of quick make and break switch manufactured by the Safety Electric Switch Company, of Providence, R. I. The switches are so constructed that the hand of the operator is at all times out of the plane of the movement of the contact knives and out of the line of an arc, if by any possibility one should be formed. Both the make and break movements are readily made and are almost instantaneous. Pulling the handle releases a cam permitting the switch to fly open or shut, as the case may be, under the action of a powerful spring. The movement in either direction once begun cannot be stopped within the danger limit. The switches are made double, triple and quadruple pole, and are especially designed for station transfer work. They are made with or without a center-stop device by means of which the contact blades can, at the will of the operator, be intercepted and held between the terminals. Fig. 24 shows a switch provided with the center-stop. With the stop handle in its normal position, as shown, the blades pass without interruption from one set of terminals to the other. The rapidity with which this is done is said to scarcely cause any lights in circuit to flicker. Fig. 23 shows a double-pole single-throw switch without the center-stop device. The switches are all polished and mounted on slate bases.



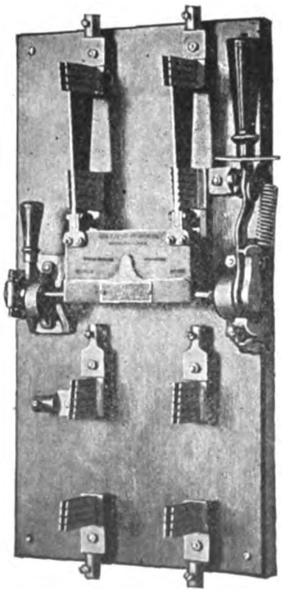


FIG. 23.—QUICK-ACTION SWITCHES.—FIG. 24.

NEW ENTRANCE SWITCH.

Fig. 25 illustrates a new entrance switch combining many novel features. The base is made of slate, having two V-shaped grooves into which the combined knife blade and contact posts fit. These being drawn down into the grooves by the screws fastening them to the base, are brought into alignment. The slate is from the Monson mine and is oil finished. The handles are finished smooth and the crossbars are grooved to prevent the blades from turning. All of the dimensions of the switch are said to comply with the rules and to be approved by the National Board of Fire Underwriters and the Manufacturers' Mutual Companies. The switch requires but little space for its capacity, and may be used for all purposes for which baby knife switches are used, and for entrance or motor switches as well. They are manufactured and sold by the Marshall-Sanders Company, Boston, Mass.

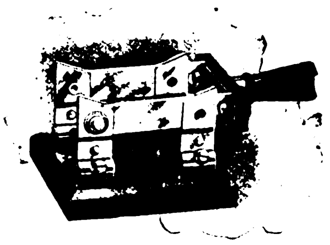


FIG. 25.—COMPACT MAIN SWITCH.

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NEW BOOKS.

Standard Polyphase Apparatus and Systems. By M. A. Oudin. (Third edition.) New York: D. Van Nostrand Company. Cloth; 289 pages, 5¼ x 8 ins.; 169 illustrations. Price, $3.00.

Many of the blemishes noticed in the earlier editions of this book have been eliminated, and the book has been brought practically up-to-date. The section on generators now includes the compensated-field type and references to the huge machines recently constructed for the big New York stations, and the chapter on station equipment has been greatly improved. The author still retains the symbols U for impedance and S for reactance, presumably in order to differ from everyone else on earth; and the reciprocal of $\sqrt{3}$ is taken as .5775 instead of .57735, but this latter discrepancy is negligible. As in the previous editions, the transmission line constants relating to the calculation of circuits are based on a distance of 18 inches from wire to wire of a circuit, but the author does not say so and does not even refer to the effect of the distance apart upon the drop. The application of the formulas, tables or diagrams to a circuit having wires 12 or 24 inches apart would, of course, produce materially inaccurate results, the actual drop for circuit wires 12 inches apart being less, and that for 24-inch separation being more, than the use of Mr. Oudin's data would show.

The Indicator Handbook.—Part II. By Charles N. Pickworth. London: Emmott & Co., Ltd. Cloth; 132 pages, 5 ins. x 7 ins.; 148 illustrations. Price, 3 shillings: in the United States, $1.50.

This is a companion book to the volume issued as Part I in 1899, the present book being devoted to the analysis of the indicator diagram. This subject is very thoroughly treated, and in a rather more dignified style than one is accustomed to find in elementary works. A somewhat unusual feature is the total absence of tables based on Mariotte's law; the author gives a table of terminal pressures in which two values are shown for each expansion ratio; one based on Rankine's formula, $pv^{1.0625}$ ("saturated" expansion) and the other on Rankine's formula, $pv^{1.111}$. (adiabatic expansion, which is never approached). The book contains a brief reference to the use of the planimeter, which might have been considerably amplified to advantage, but otherwise there is little cause for criticism.

Dynamos, Alternators and Rotary Converters. (Third edition.) By Gisbert Kapp. Translated from the German by Harold H. Simmons. London: Biggs & Co. Cloth, 506 pages, 5½ x 8½ ins.; 200 illustrations. Price, 10½ shillings.

This edition of Mr. Kapp's excellent book shows pruning in some places and considerable elaboration in others in comparison with the earlier editions. The discussion of commutation is very much fuller and the treatment of the subject more rational than heretofore. Magnetic leakage, armature reaction of alternators and armature windings in general have been given a much larger share of attention. The discussion of transformers has been eliminated, as this is fully covered by Mr. Kapp's book on that subject; a section on rotary converters and alternating-current motors has been added. The author still clings, however, to the now obsolete method of computing the excitation required for field magnets which involves the calculation of reluctances, and the Kapp flux unit of 6000 C. G. S. lines is employed, wherever the C. G. S. system is not used, to the very great disadvantage of American readers. The first seven chapters, excepting possibly the permeability curves, might as well have been left out, as they deal with elementary principals which are perfectly familiar to everyone who is capable of understanding and applying the remainder of the contents. The engravings are wretched, and the system of nomenclature leaves much to be desired. A consistent system, with a table of symbols, would have added greatly to the merits of the book, which are high even after allowing for the drawbacks noted.

NATIONAL ELECTRIC LIGHT CONVENTION NOTES

C. K. HILL, Pittsburg, Pa., was at the convention meeting his many friends.

G. H. SCHEEFFER, Peoria, Ill., represented the Diamond Meter Company.

L. D. SKINNER, Jr., of the Skinner Engine Company, Erie, Pa., was in attendance.

JAMES WOLFF was on hand in the interests of the New York Insulated Wire Company.

GEO. T. MANSON, of the Okonite Company, was one of those in attendance at the convention.

U. S. CARBON COMPANY, of Cleveland, was represented by B. P. Foster, its general manager.

HUBBARD, HALL & COMPANY, Cincinnati, were well represented by W. A. Hall and G. H. Jones.

AMERICAN ELECTRICAL WORKS, Providence, R. I., were represented by F. E. Donohue.

C. J. HARRINGTON, of New York, represented the Scranton Fire Brick, Clay & Conduit Company.

COLONIAL ELECTRIC COMPANY, Ravenna, Ohio, sent J. B. Esterbrook to look after its interests.

THE SUNBEAM INCANDESCENT LAMP COMPANY was represented by its vice-president F. S. Terry, of New York.

WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., was represented by C. C. Badeau.

MANHATTAN ELECTRICAL SUPPLY COMPANY, New York, sent J. W. McDowell to look after its interests.

C. A. SANDERS, of the Marshall-Sanders Company, Boston, Mass., represented his company at the convention.

ROBERT KELLY, Jr., of Newark, Ohio, and M. J. Davies represented the Holophane Glass Company, of New York.

ROSSITER, MacGOVERN & CO., New York, dealers in electrical and other new and second-hand machinery, were ably represented in the persons of Frank MacGovern and J. A. Pierce, the Western representative of the company.

THE NERNST LAMP COMPANY was represented by Calvin W. Rice, A. E. Fleming and A. J. Wurts, of Pittsburg, Pa.

THE AMERICAN CIRCULAR LOOM COMPANY, Chelsea, Mass., was represented by H. B. Kirkland and Thos. G. Grier.

BRYAN-MARSH COMPANY and "Imperial" incandescent lamps were ably represented by C. D. Marsh and G. C. Keech.

NEW YORK & OHIO COMPANY, Warren, Ohio, manufacturers of lamps, transformers, etc., was represented by W. D. Packard.

THE PHOENIX GLASS COMPANY, New York, well known makers of globes and shades for electric lights, was represented by E. H. Peck.

PRESIDENT J. C. SHAINWALD was present in the interests of the Standard Paint Company of New York, as was also H. W. Benedict.

T. O. MOLONEY, of St. Louis, Mo., president of the Moloney Electric Company, manufacturer of transformers, was present in the interests of his company.

WESTERN ELECTRIC COMPANY was represented by Robert Edwards, Jr., and E. W. Rockefellow, of New York, and J. J. Kessler, of St. Louis.

THE ROBBINS & MYERS COMPANY, Springfield, Ohio, was well represented by Messrs. W. W. Mumma, R. P. Thompson and Mr. Conklin.

J. G. CONNOR & CO., Philadelphia, distributed some interesting literature regarding their "Battery Black Paint," which not only insulates, but prevents corrosion.

JOHN DALE, of New York, was present with O. J. Bryan, in the interests of the Dale Company, which manufactures electrical specialties of many kinds.

PASS & SEYMOUR, Solvay, N. Y., the well-known porcelain manufacturers, were ably represented by C. W. Crofoot, of Cincinnati, and F. M. Hawkins, of New York.

HART & HEGEMAN MANUFACTURING COMPANY, Hartford, Conn., manufacturers of the celebrated H. & H. switches, sent R. B. Corey as their representative.

ADAMS-BAGNALL ELECTRIC COMPANY, Cleveland Ohio, was represented by J. G. Pomeroy, in charge of the Western sales of its well-known lamps, at Chicago.

G. S. SEARING, of Chicago, was present on behalf of the Peru Electric Manufacturing Company, Peru, Ind., and the Hart & Hegeman Manufacturing Company, Hartford, Conn.

E. J. McALLISTER, Newark, N. J., represented the Electric Motor & Equipment Company, showing the photometer and sign commutating devices manufactured by this company.

THE OSBORN FLEXIBLE CONDUIT COMPANY, New York, exhibited samples of its product at the convention, and was represented by C. E. Corrigan and J. S. Monroe.

J. A. HEANY, inventor of the Heany arc lamp, was present to represent the Americal Electric Manufacturing Company, of Philadelphia, and exhibited a number of lamps which attracted much attention.

JAS. I. AYER, one of the past presidents of the association and manager of the American Electric Heating Corporation (department of the Simplex Electric Company), Cambridgeport, Mass., was, as usual, in active attendance and cordially welcomed by all of his old friends as well as by many new ones.

CENTRAL ELECTRIC COMPANY, of Chicago, was represented by A. S. Pearl.

THE JANTZ & LEIST ELECTRIC COMPANY sent C. T. Schlochtermeyer as their representative.

LUNKENHEIMER COMPANY, of Cincinnati, was represented by David C. Jones, S. L. Meyer, and others.

GREEN FUEL ECONOMIZER COMPANY, Matteawan, N. Y., sent W. J. Best from their Chicago office.

LOMBARD GOVERNOR COMPANY, Boston, Mass., was ably represented by its manager, Allen V. Garratt.

DEARBORN DRUG & CHEMICAL COMPANY were represented by Dan Delaney, of Cincinnati, and R. W. Francis, of Chicago.

W. J. PHELPS, of the Phelps Company, Detroit, Mich., explained to many interested visitors the merits of the well-known "Hylo" lamp.

ROYAL ELECTRIC COMPANY, of Peoria, Ill., manufacturers of alternators and transformers, sent G. G. Luthy as their representative.

AMERICAN DISTRICT STEAM COMPANY, Lockport, N. Y., sent H. C. Eddy, of Chicago, and C. R. Bishop to look after its interests.

ELECTRIC STORAGE BATTERY COMPANY, Philadelphia, Pa., was represented at the convention by Messrs. Blizard, Stebens and Atkin.

ELECTRIC APPLIANCE COMPANY, Chicago, was adequately represented by the versatile W. W. Low, as well as by G. B. Fairbanks and A. L. Millard.

W. O. GARRISON, president of the Columbia Incandescent Lamp Company, St. Louis, was an enthusiastic participant in the various exercises and functions.

J. S. HINDS, of Syracuse, N. Y., and C. M. Crofoot, of Cincinnati, Ohio, were present in the interests of the Crouse-Hinds Electric Company, of Syracuse.

J. A. VAIL appeared on behalf of the Hooven, Owens & Rentschler Company, of Hamilton, Ohio, whose engines are becoming favorably known in the electrical field.

S. B. CONDIT, Jr., of S. B. Condit, Jr., & Co., Boston Mass., was a late arrival, but interested many of the delegates in the Elden oil circuit-breakers and switches which his firm manufactures.

WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, had the interests of its "Peerless" lamps, fans and transformers ably taken care of by Messrs. E. W. Gillmer and E. E. Nash.

BULLOCK ELECTRIC MANUFACTURING COMPANY was well represented during the days of the convention by members of its various departments. Among them may be mentioned Geo. Bullock, president of the company; B. A. Behrend, L. B. Hoyt, F. G. Bolles; Alfred Collyer, of Montreal; S. J. Hendy, of San Francisco; J. A. Summers, of Knoxville, Tenn.; G. B. Thurber, of Pittsburg; Messrs. M. F. Quill, Geo. M. Gest and W. R. Harris, of the Cincinnati office, and Mr. Lozier, manager of the New York office.

GOULD STORAGE BATTERY COMPANY, of New York, was represented by Messrs. Wm. W. Donaldson and A. S. Hubbard, both of New York, and also by Messrs. Chas. M. Gould and F. P. Huntley.

CHASE-SHAWMUT COMPANY, of Boston, Mass., had an able representative in H. B. Moore, who interested many of the delegates in the new indicating enclosed fuse recently placed on the market by this company.

THE JOHN A. ROEBLING'S SONS COMPANY sent a large delegation, including W. P. Bowman, of Cleveland, Geo. C. Baley, of Chicago, F. W. Harrington, of New York, and D. F. Ivins, of Trenton.

GENERAL INCANDESCENT ARC LIGHTING COMPANY, of New York, were not only represented by several thousand enclosed arc lights on Cincinnati circuits, but by Messrs. Martin Insull, Hallberg and Colwell.

THE PETTINGELL-ANDREWS COMPANY, Boston, Mass., through its representative, W. J. Keenan, distributed leather-bound copies of the Underwriters' Rules, a souvenir much appreciated.

THE NATIONAL ELECTRIC IMPROVEMENT COMPANY, New York, made an excellent display of their "Elblight" system under the efficient direction of Russell Spaulding, no fewer than 4,000 lights being used in decorating the front of the hotel, the rotunda and corridors.

THE TRIUMPH ELECTRIC COMPANY, of Cincinnati, needed no exhibit to add to the popularity of its motors and dynamos, but gave away a neat souvenir in the shape of a tape measure. The company was ably represented by J. C. Hobart, W. H. Jacob, C. S. Reno and D. D. Gill.

AMERICAN VITRIFIED CONDUIT COMPANY had an exhibit of its conduit in the long hall, under the management of G. M. Gest. A huge manhole on the Cincinnati Gas and Electric Company's system, 11 feet by 11 feet by 11 feet, was fitted up as a reception room, to which the delegates were invited.

DR. FRED'K C. PERRINE, of Pittsfield, Mass., Ray D. Lillibridge and B. W. Bergenthal, were present in the interest of the Stanley Electric Manufacturing Company. Copies of Dr. Perrine's paper on "The Power Plants of the Pacific Coast," and an interesting treatise on "Recent Transformer Litigation," were distributed to the delegates.

STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, was represented by J. R. Wiley, Chicago; T. E. Hughes, of Philadelphia, and C. J. Marsh, of New York. The company had an exhibit including samples showing pipe and rubber insulated lead-covered underground cables for very high voltages, and distributed much literature.

THE SHEDD ELECTRIC & MANUFACTURING COMPANY, of New York, maker of oscillating electric fans, sent Theo. D. Moulten to look after its interests. This company's exhibit of three fans in the center of the rotunda of the hotel attracted much favorable comment and contributed much to the comfort of those in attendance.

THE "X.-S." CAPACITY INDICATOR was shown in operation in the long hall by the Excess Indicator Company, of Boston, Mass., who are following up the work done by Mr. Walls, of Woburn, with his "4-C" system. The company was represented by R. J. Patterson and G. K. Boutelle, who showed the indicator under test on a bank of lamps.

J. JONES, JR., representing J. Jones & Son, New York, had on exhibition several interesting novelties, including an automatic time cut-out device and automatic time switches; also an ingenious rotary ceiling switch and a neat showcase lighting fixture. The firm distributed a neat memorandum pocketbook which concontained much valuable information.

STERLING ELECTRIC MANUFACTURING COMPANY, Warren, Ohio, was fortunate in having its interests taken care of by Messrs. Wm. Coale, Glenn C. Webster and J. W. McNair, who distributed copies of the Sterling Company's recent booklet, "The Midnight Sun," as well as other literature descriptive of the Sterling "Special" lamp.

FT. WAYNE ELECTRIC WORKS, Ft. Wayne, Ind., had on exhibition a number of their arc lamps, type "K" meters, motor-starting panels, instruments and revolving fan motors with cord suspension. Representing the Fort Wayne interests were F. S. Hunting, A. A. Serva, T. L. Sturgeon, T. J. Ryan, G. B. Edgar, J. E. Hall, W. S. Goll and W. C. Knight.

THE DAILY BULLETIN, issued by the Bullock Electric Manufacturing Company, under the editorship of Mr. F. G. Bolles, was a great convenience, being of vest-pocket size and containing an excellent map of Cincinnati, the program and other matter. Each person in attendance was assigned a numbered card and received a numbered button. The name, number, etc., were printed in the bulletin in full, proving very handy for reference.

GENERAL ELECTRIC COMPANY occupied a parlor, but made no exhibit, contenting itself with the distribution of literature and with the display of a sign in miniature lamps outside its headquarters. It was represented by Messrs. J. R. Lovejoy, of the lighting department; A. D. Page, of the incandescent lamp sales department; J. B. Pevear, of the Cincinnati office; C. B. Davis, of the Boston office; Irving Hale, of the Denver office; A. L. Rohrer, E. E. Gilbert, P. D. Wagoner, H. W. Hilman and F. Vaughan, of the Schenectady works; E. H. Mullin, of the New York office; R. Fleming and F. B. Cox, of Lynn, and several others.

SPRAGUE ELECTRIC COMPANY, New York, was represented by Alex. Henderson, of the conduit department, who had on exhibition samples of the company's steel-armored conduits, ranging in sizes from signal, bell and telephone work up to the largest runs of light and power circuit. The flexibility and adaptability of the system were admirably elucidated by Mr. Henderson.

THE WESTINGHOUSE ELECTRIC & MAUFACTURING COMPANY had a most interesting exhibit at the convention, which consisted of a large variety of instruments. The Westinghouse interests were represented by W. M. Probasco, C. B. Humphrey, W. S. Rugg, J. W. Shantz, H. C. March, R. U. C. Barnes, W. R. Pinckard, C. S. Powell, W. H. Whiteside, A. Goodby, H. D. Shute, G. B. Griffin, C. F. Scott, C. Townley, E. Gawger, F. Hodkinson, T. H. B. Whiffie and G. A. Nellis, the two latter also being in charge of the Sawyer-Mann Electric Company's interests with C. A. Ross.

BANNER ELECTRIC COMPANY, Youngstown, Ohio, was represented by Messrs. N. L. Norris, J. E. Hart, F. C. Kirchner, and R. T. Hamilton. The company exhibited a complete assortment of Banner lamps of various types and voltages, prominent among which were a new 220-volt lamp and a standard 16-c.p. lamp. An attractive folder, prepared expressly for the occasion, and entitled "The Right of Way," was handed to all visitors. The company also distributed numerous little dice boxes as souvenirs.

NATIONAL CARBON COMPANY was represented by N. C. Cotabish, its well-known sales manager, who, in view of the universal use of its product by central station men, deemed it unnecessary to make an exhibit of points or brushes, etc. The company was also represented by A. D. Spear and F. H. Murray, of Cleveland; F. H. McDowell, of Pittsburg; A. E. Carrier, of New York, and F. C. Park, of Boston.

INDEPENDENT TELEPHONE CONVENTION NOTES

NATIONAL INDIA RUBBER COMPANY was efficiently represented by H. Stanley.

NOVELTY ELECTRIC COMPANY, of Philadelphia, was represented by its secretary, C. E. Trump.

ILLINOIS ELECTRIC SPECIALTY COMPANY, Chicago, was represented by P. J. Hertz and F. B. Patton.

STERLING ELECTRIC COMPANY, of Lafaytte, Ind., was represented by the ever-popular W. E. Doolittle.

AMERICAN ELECTRICAL WORKS, of Providence, R. I., was represented by W. J. Watson, of New York.

WESTERN ELECTRIC COMPANY was represented by H. G. Braynard and Fred C. Jaeger, of the Philadelphia Branch store.

AMERICAN TOLL TELEPHONE COMPANY, Cleveland, Ohio, was ably represented at the convention by W. A. Foss and J. R. McLean.

H. C. ROBERTS & CO., of Philadelphia, well-known dealers in supplies and specialties, were represented by H. C. Roberts and John Mustard.

McROY CLAY WORKS was represented by E. F. Kirkpatrick. It is unnecessary to state that the representation was effective and continuous.

MANHATTAN ELECTRICAL SUPPLY COMPANY, of New York, added to its long list of telephone friends through the efficient representation of I. M. Post.

CHASE-SHAWMUT COMPANY, of Boston, Mass., was represented by Harry P. Moore, who distributed interesting literature relative to the company's Boston cable slip.

GORDON BATTERY COMPANY exhibited its well-known heavy-duty primary battery, the merits of which were ably explained by W. C. Banks, of the Chicago office.

ATWATER KENT MAUFACTURING WORKS, Philadelphia, makers of the Monoplex telephone outfit, which was described last month in this paper, was represented at the convention by Mr. Kent.

CLARK AUTOMATIC TLEPHONE COMPANY, Providence, R. I., made a large number of new friends and renewed old friendships through J. L. Putnam and Louis Stillings.

ALFRED F. MOORE, of Philadelphia, the well-known manufacturer of insulated wire, was present in person and was assisted in representing his interest by E. B. Bartram and W. W. Pawling.

JAS. G. BIDDLE, of Philadelphia, Pa., had a fine exhibit of electrical instruments in Room 933. The exhibit included testing apparatus and condensers for central energy telephone systems.

NEW HAVEN NOVELTY MACHINE COMPANY had an interesting exhibit in the Keystone Telephone Building in charge of Chas Luke, H. Grant Thompson and Franklin A. Thompson.

CROCKER-WHEELER COMPANY, Ampere, N. J., was represented by J. R. Wilson, who lost no opportunity to explain the merits of the company's dynamotors and motor-dynamos for telephone signaling.

THE F. BISSELL COMPANY, Toledo, Ohio, showed an assortment of pole-line specialties in a room in the Hotel Walton. These included pole seats, conduit rods, cable distributing boards, etc., the merits of which were ably presented by C. M. Hamilton.

THE RUSSELL-TOMLINSON ELECTRIC COMPANY, of Danbury, Conn., had an exhibit in the Keystone Building comprising three new types of desk instruments and several receivers and transmitters. The company was represented by W. E. Russell.

THE SUMTER TELEPHONE MANUFACTURING COMPANY, Sumter, N. C., had a fine exhibit of telephone sets and parts in a room in the Hotel Walton. The company emphasizes the fact that every part of its apparatus is manufactured in its own factory, and its product shows a vast number of improvements in small details which are inconspicuous in themselves, but have a vital effect upon the efficiency of the apparatus as a whole. The company was represented by Secretary F. C. Manning and L. G. Le Bourveau, who made hosts of friends for their products.

D. & W. FUSE COMPANY, Providence, R. I., was represented by W. S. Sisson, W. J. Leggett and F. C. Jaeger. The company had on exhibition its latest form of double-pole telephone protector.

VARLEY DUPLEX MAGNETIC COMPANY, Phillipsdale, R. I., was represented by J. M. Knox, who took pains to allow no one to overlook the merits of the Varley machine-wound magnetic coils.

ERICSSON TELEPHONE COMPANY, New York, was represented by K Weman and C. E. Monroe, who explained the merits of the Ericsson switchboards and other apparatus exhibited at the convention.

VALLEE BROS. ELECTRICAL COMPANY, of Philadelphia, was most efficiently represented by Thos L. Townsend. There are few, if any, in the telephone and general supply business who are not familiar with Mr. Townsend's amiable personality.

HELIOS-UPTON COMPANY, Philadelphia, was represented by Chas. D. Meyers and Harry Huskey, who distributed attractive circulars containing illustrations and descriptions of Helios-Upton lightning arresters, cable terminals, telephone batteries, etc.

KELLOGG SWITCHBOARD & SUPPLY COMPANY had a most attractive exhibit in the Keystone Telephone Building. The company was represented by A. E. Barker, J. C. Belden, Paul W. Bossert, F. J. Dommerque, Arthur B. Kratz, Kempster B. Miller and S. C. Platt.

LAMBERT SCHMIDT TELEPHONE MANUFACTURING COMPANY, of New York, exhibited a 200-line common-battery switchboard with automatic self-restoring drops and supervisory lamps, and a 10-drop bridging board in which cams were used instead of cords, plugs and jacks. The company was ably represented by Lambert Schmidt and Messrs. Roche and Bostwick.

WARNER ELECTRIC COMPANY, of Muncie, Ind., had an interesting exhibit of its vibrator for changing direct current into alternating for telephone signaling. The exhibit was in charge of T. W. Warner, and was operated in connection with apparatus in the Kellogg exhibit.

VIADUCT MANUFACTURING COMPANY, Baltimore, Md., had no formal exhibit at the convention, but referred delegates to a beautiful little central-energy switchboard in operation at the office of the United Telephone & Telegraph Company. The Viaduct Company was represented by Marion B. Davis and Wm. O. Le Bauer.

AMERICAN ELECTRIC TELEPHONE COMPANY, of Chicago, had its headquarters in Rooms 913 and 915, at the Hotel Walton, where a host of friends were received. President P. C. Burns and Messrs. H. P. Clausen, John H. Reid, S. J. Bear and J. G. Ihmsen looked after the company's interests.

NORTH ELECTRIC COMPANY, of Cleveland, Ohio, had one of the most complete and attractive exhibits at the convention. This was located on the ground floor of the Keystone Telephone Building and attracted a great deal of attention. The company was represented by C. H. North, R. Hendrickson and F. F. Sapp.

ELECTRIC STORAGE BATTERY COMPANY exhibited several types of "chloride" accumulators especially designed for telephone work, among which were some new wells of smaller size than usual, designed especially for small central agency exchanges. The company was ably represented by E. L. Reynolds, H. B. Coho and R. C. Hull.

GENERAL ELECTRIC COMPANY'S LAMP WORKS were represented by F. W. Willcox and H. Westberry. These gentlemen brought with them some extremely attractive souvenirs in the shape of miniature lamps made up in the forms of scarf pins and watch charms. It is unnecessary to say that the stock of souvenirs was exhausted within a very short time.

STROMBERG-CARLSON TELEPHONE MAUFACTURING COMPANY was represented by J. J. Nate, Eugene F. Brown, S. L. Reese, A. J. Rousseau and C. W. Stiger. The company had an exhibit in the Keystone Telephone Building which attracted a large number of delegates and demonstrated very effectively the excellence of the Stromberg-Carlson apparatus.

HOLTZER-CABOT ELECTRIC COMPANY, Brokline, Mass., had an excellent exhibit in the Keystone Telephone Building, comprising a Ness automatic desk telephone set, a dynamoter giving alternating current for ringing and pulsating current for party line signals, and several other interesting specialties. The company was represented by J. J. Estabrook and D. M. Bliss.

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PERSONAL.

MR. P. T. DUNN has been appointed superintendent of the Cincinnati, Georgetown & Portsmouth (Ohio) Railroad Company.

MR. W. G. EVANS, formerly secretary of the Denver (Col.) Tramway Company, has been elected president of that company.

MR. C. W. HUNT, of the well-known Hunt Company, of New York, sailed with his family recently for an extended visit to Scotland.

MR. WALTER MUELLER, who is associated with Mr. Ray D. Lillibridge, of New York, was married to Miss Meta Hepworth Thomas at Trenton, N. J., on June 21.

MR. EDWARD WOLFE has been appointed chief electrical engineer of the city electric light plant of Greenfield, Ind., succeeding Mr. Geo. H. Gant, who resigned recently.

MR. G. F. GREENWOOD has been appointed agen for the sale of "Chloride" accumulators in Cuba. Mr. Greenwood's offices are located at 34 Empedrado Street, Havana.

MR. JAMES ROWLAND BIBBINS has resigned assistant electrical engineer of the Detroit United Railway to accept a position in the Westinghouse Companies' Publishing Department.

MR. A. B. AYRES, who has been for some time a member of the Chicago staff of the Westinghouse Company, has resigned his position there to connect himself with the well-known engineering firm of Sargent & Lundy.

MR. DAVID S. HULFISH, formerly switchboard engineer of the Central Union Telephone Company, has been appointed electrical engineer of the Baird Manufacturing Company, of Chicago, and has also been elected secretary of the company.

MR. WILLIAM E. HAYCOX, who has been general manager of the Ohio Central Traction Company since 1897, resigned that position recently. Mr. Haycox's plans for the future have not yet crystallized into definite shape.

MR. STEPHEN D. FIELD, of New York, the well-known electrical engineer and inventor, has returned to the United States after a stay of three years in Europe, where he has been giving attention to extensive electric railway projects.

MR. ALEX. C. HUMPHREYS, of New York, has been elected president of Stevens Institute, Hoboken, N. J., to succeed the late Dr. Henry Morton. Mr. Humphreys graduated from Stevens in 1881 and is now a prominent gas engineer.

MR. D. W. COOKE, general passenger agent of the Erie Railroad, recently gave a most enjoyable outing, taking a party of newspaper men and ladies to Buffalo and Niagara Falls. The trip extended over three days and it is needless to say that it was fully enjoyed by the participants.

MR. ALFRED STROMBERG, president of the Stromberg-Carlson Telephone Manufacturing Company, sailed from New York recently for a visit to his old home near Stockholm, Sweden. Mr. Stromberg, after his visit to Sweden and Norway, will make a short visit to England and France.

MR. H. F. SANVILLE, who has been for several years past secretary of the Morris Electric Company, Philadelphia, Pa., has severed his connection with that company in order to go into business on his own account. Mr. Sanville will establish an agency in Philadelphia and represent several prominent manufacturers.

MR. C. W. STIGER, who has been superintendent of construction for the Stromberg-Carlson Company for some time past, has been appointed manager of the re-organized Stromberg-Carlson Telehpone Manufacturing Company. Mr. Stiger has had a wide experience in telephone work, and has proved, as his advancement indicates, a most valuable man to his company.

MR. RUSSELL BAKER, who has been superintendent of the Electric Light & Water Company of Little Falls, Minn., for nearly fourteen years, has retired from that position. The plant was recently purchased by the Morrison County Electric Heat, Light & Power Company, who had built a competing plant, and Mr. Baker was offered a position with the new company at his old salary, but declined it, preferring to make a change in his line of work.

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TRADE PUBLICATIONS.

NEW PROCESS NOISELESS PINIONS. The New Process Raw Hide Company, Syracuse, N. Y. —This is an extremely convenient catalogue of vest-pocket size, containing a description of the New Process raw-hide pinions and a complete price list of blanks and finished pinions in all sizes from 1 in. face and 2 ins. outside diameter up to 10 ins. face and 15 ins. outside diameter.

A COMMUTATOR NECESSITY.

GALES
COMMUTATOR COMPOUND.
SEE THAT YOUR COMMUTATOR
DIRECTIONS FOR USE

For Sale by all Supply Houses.
Upon receipt of this coupon we will send FREE, sample stick.

Name..
Address...
A. E.

The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO

WHAT'S A FLASHER? Reynolds Electric Company, Inc., Chicago, Ill.—A folder devoted to the improved Reynolds flasher which was described recently in the New Apparatus department of this paper.

SMALL POWER MOTORS.—Crocker-Wheeler Company, Ampere, N. J.—A well-executed catalogue of pocket size, devoted to the Crocker-Wheeler line of motors and dynamos ranging from the smallest fan motor size up to 45 horse-power or 40 kilowatts.

MOTOR-DRIVEN AIR COMPRESSORS. Christensen Engineering Company, Milwaukee, Wis.—Catalogue No. 51, containing many illustrations and a detailed description of the Christensen motor-driven air compressors for street and elevated railway air-brake equipment.

THE NEW STANDARD DRY BATTERY. Wm. Roche, N. Y.—A small pamphlet of vest-pocket size which, notwithstanding its diminutive dimensions, contains a great deal of extremely interesting information as to dry batteries in general and the "New Standard" battery in particular.

SCHOOL HANDBOOK. American School of Correspondence, Boston, Mass.—This is the 1902 edition of the American School's handbook, which contains full information concerning the admirable engineering courses of the school, together with specimen examination papers reproduced in *fac simile* and a number of flattering testimonial letters.

AMERICAN STANDARD COPPER COIL FEED-WATER HEATER. The Whitlock Coil Pipe Company, Hartford, Conn.—This is catalogue No. 22-H, containing an illustrated description of these well-known feed-water heaters. The catalogue also contains references to the American reheating receiver and a long list of users of these excellent pieces of apparatus.

DISC VENTILATING FANS. American Blower Company, Detroit, Mich.—Catalogue No. 140, containing illustrations and price lists of these fans, which are supplemented by a thorough description of the fans' construction, with sectional illustrations. The catalogue also contains some useful tables of fan capacities and speeds and other data relating to the handling of air.

RECENT TRANSFORMER LITIGATION. Stanley Electric Manufacturing Company, Pittsfield, Mass.—An illustrated folder containing an interesting argument concerning the decision recently handed down degarding the original Stanley patent owned by the Westinghouse Company. The larger part of the folder, however, is devoted to a detailed description of the Stanley A. O. type transformer.

KEYSTONE INCANDESCENT LAMPS. Pittsburgh Incandescent Lamp Company, Pittsburg, Pa. An attractive catalogue of Keystone Lamps, which are made in all standard candle-powers and for all of the usual classes of service.

STORAGE BATTERY ISOLATED PLANT. Gould Storage Battery Company, New York. Bulletin No. 1, containing an illustrated description of the battery plant installed for Mr. Geo. W. Vanderbilt at Biltmore, N. C., by the Gould Company.

THE WILLANS ENGINE. Bradley Manufacturing Company, Pittsburg, Pa.—A well-executed catalogue containing a profusely illustrated description of the Willans high-speed engine, the rights to manufacture which have been recently taken over by the Bradley Manufacturing Company.

MODERN METHODS.—The Link-Belt Engineering Company, Philadelphia, Pa. This is the latest edition of this elaborate and admirable book devoted to the elevating and conveying of coal and other materials. It is profusely illustrated and has, of course, been brought strictly up-to-date. The book is handsomely executed and substantially bound. Its contents are too comprehensive to admit of a detailed review; it will suffice to say that the full line of conveying apparatus built by the Link-Belt Company is illustrated and described.

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BUSINESS NEWS.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, of Warren, Ohio, recently distributed some very attractive aluminum ash trays in which the name of the Sterling "Special" lamp and the address of the company were embossed, together with an excellent representation of the lamp itself.

W. S. HILL ELECTRIC COMPANY, New Bedford, Mass., reports that its business has increased more than 50 per cent. during the past twelve months. The company manufactures the well-known Hill switches and switchboard apparatus and enjoys a flourishing business in complete switchboards, panel boards, etc.

ATWATER KENT MANUFACTURING WORKS, of Philadelphia, has placed on the market a very compact telephone outfit which is supplied in a box already for installation. The new Monoplex telephone which the company recently put out has met with a very flattering reception and indications are favorable for a large busness in this type of instrument.

JOHNSON & MORTON, of Utica, N. Y., have established a New York office at 232-234 Greenwich Street, which will be in charge of Messrs. Frorup and Levy, both of whom are well known in local electrical circles.

BRYAN-MARSH COMPANY, New York, has secured a long lease on a commodious ground floor office at 136 Liberty Street, together with a large basement wareroom where a full stock of incandescent lamps will be carried.

ROSSITER, MAC GOVERN & CO., of New York, recently bought the greater part of the machinery, including the engines and generators, formerly used in the 146th street station of the Metropolitan Street Railway Company, New York.

THE WILLARD STORAGE BATTERY COMPANY, Cleveland, Ohio, has succeeded to the factory and business which has been conducted under the firm name of Sipe & Sigler during the past two years, and will continue the manufacture of Willard storage batteries.

C. J. TOERRING COMPANY, Philadelphia, Pa., manufacturer of the well-known Toerring arc lamp, has removed its headquarters to the Warden Power Building, Nineteenth Street and Allegheny Avenue, in order to secure the additional accommodations necessitated by the rapid growth of its business.

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PASS & SEYMOUR, of Solvay, N. Y., announce that their lamp sockets have been approved by the National Board of Fire Underwriters for 250-volt circuits.

THE BAIRD MANUFACTURING COMPANY, Chicago, Ill., has for some time past been engaged in developing a rapid-service single-coin machine for telephone pay stations and also a rapid-service meter for telephone lines. The new machines are almost ready for market.

THE CONSUMERS' CARBON COMPANY, of Lancaster, Ohio, it is reported, was sold recently to Cleveland parties, who have assumed control of the plant and re-organized the company. The new officers are said to be Chas. S. Britton, president; A. M. Britton, vice-president, and B. L. Britton, secretary and treasurer.

THE SCRANTON FIRE BRICK & CONDUIT COMPANY, with factories at Scranton, Pa., and Ithaca, N. Y., is putting out a vitrified conduit for electrical underground construction which is claimed to have unusually high insulating qualities and to be proof against chemical action of any kind.

CENTRAL MANUFACTURING COMPANY, Chattanooga, Tenn., suffered the misfortune of having its factory entirely destroyed by fire on May 10. With characteristic progressiveness, however, the company immediately made arrangements whereby it has been able to take care promptly of all orders.

THE SIMS COMPANY, of Erie, Pa., had an extremely attractive display of steam specialties at the steam engineers' convention recently held at Reading, Pa. Mr. Henry Sims, senior member of the firm, was present in person and explained in an interesting manner the special features of the Sims feed-water heaters, steam separators, etc.

THE D. M. STEWARD MANUFACTURING COMPANY, Chattanooga, Tenn., announces that as a protection against imitations it has adopted the name "Lavite" for its lava insulating specialties, which name has been duly registered as a trade-mark and will be fully protected. The company recently established a branch office in Chicago and reports that the results of the venture have been highly gratifying, and that the office has been made permanent.

THE BANNER ELECTRIC COMPANY, Youngstown, Ohio, at its recent annual meeting voted to increase its capital stock from $35,000 to $50,000, for the purpose of enlarging its facilities in order to take care of its rapidly increasing lamp business. In view of the fact that the company has only been in operation since November of last year, this is a most remarkable showing.

THE FALCON ELECTRIC MANUFACTURING COMPANY, of New York, has opened a downtown office at 15 Cortlandt Street, where a complete line of its standard apparatus will be carried for the convenience of the electrical trade in the lower part of the city. The chief business office of the company will be located at this address and all communications should therefore be sent to the Cortlandt Street office in future.

CLARK AUTOMATIC TELEPHONE SWITCHBOARD COMPANY, Providence, R. I., has established an agency in Chicago in the hands of Brown & Leasure, whose headquarters are in the Fisher Building. The company's apparatus has rapidly grown in favor and its export business has been remarkable. Automatic switchboards have been installed in England, Germany, Holland, South America and South Africa.

INDUCTION MOTORS IN MACHINE WORKS.—The Continental Iron Works, of Brooklyn, N. Y., recently purchased from the Westinghouse Company a 180-kw. 60-cycle two-phase alternator and 11 induction motors ranging from 5 to 20 horse-power each, to augment its previous equipment of alternators and motors which aggregated about 170 kilowatts. The induction motors are to be used for driving corrugating and bending rolls, fans, shears, machine tools, etc.

THE SAFETY INSULATED WIRE & CABLE COMPANY, of New York, manufacturers of the well-known "Safety" seamless rubber-insulated wires and cables, has been reorganized with an authorized capital stock of $1,500,000, of which $1,000,000 has been issued. The officers of the new company are Benj. M. Whitlock, president; Le Roy Clark, Jr., and Ira W. Henry, vice-presidents; H. T. Richards, secretary; A. P. Lambrecht, assistant secretary; Edwin Epstein, treasurer, and A. P. Eckert, assistant treasurer. The company will be represented as heretofore in Boston by F. B. Parson, in Chicago by M. B. Austin & Co., in St. Louis by Col. E. J. Spencer, and in Detroit by the Henry L. Walker Company.

AMERICAN STEEL & WIRE COMPANY reports that the South Carolina Interstate & West Indian Exposition awarded it gold medals for rail-bonds, wire rope, copper, springs and spring wire, aluminum wire, machinery and appliances for wire drawing, as well as other products not of interest to the electrical industry; and silver medals for underground and overhead wires and cables, and several other products. The medals received represented the highest awards in each class.

THE PELTON WATER WHEEL COMPANY, of San Francisco, has just installed two pairs of turbines for Mariposa Commercial & Mining Company at Mt. Bullion, Calif., which will be direct-connected to generators and deliver 1000 horse-power for transmission over a 25-mile line. The Pelton Company has recently installed three water-wheel units of 1500 horse-power capacity each for the Keshwick Electric Power Company, which is one of the most modern and finely equipped electric power station in the West.

THE PEERLESS COMPANY, of Warren, Ohio, has been organized with $500,000 capital stock to manufacture electrical supplies. The incorporators are T. H. Gillmer, E. W. Gillmer, J. B. Perkins, Wm. Wallace, W. C. Ward, E. E. Nash and J. W. Holloway. Several of these names will be recognized as belonging to gentlemen who are connected with the Warren Electric & Specialty Company of the same city, but this does not indicate any connection between the two companies. The Peerless Company will be entirely distinct from the Warren Company, and will erect a large manufacturing plant at once.

BOOKS FOR YOUNG ENGINEERS.

A. B. C. OF THE STEAM ENGINE. Lisk. An up-to-date book with six folding plates of scale drawings and full particulars. Cloth. 50 cents net.
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LUBRICANTS, OILS AND GREASES, $1.50.
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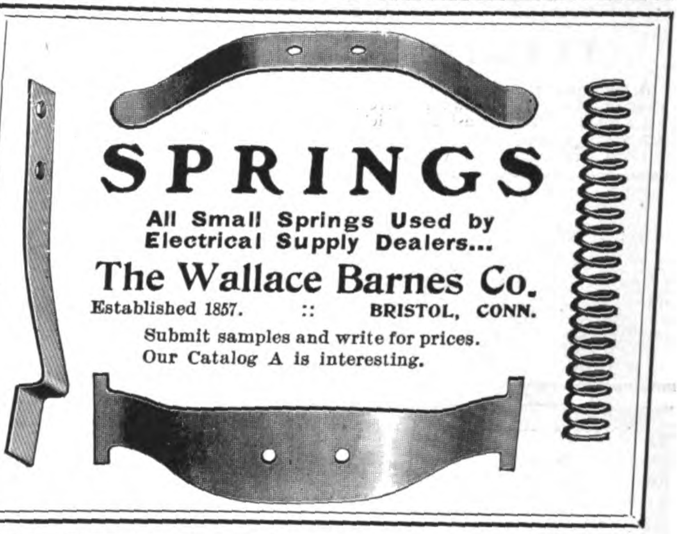

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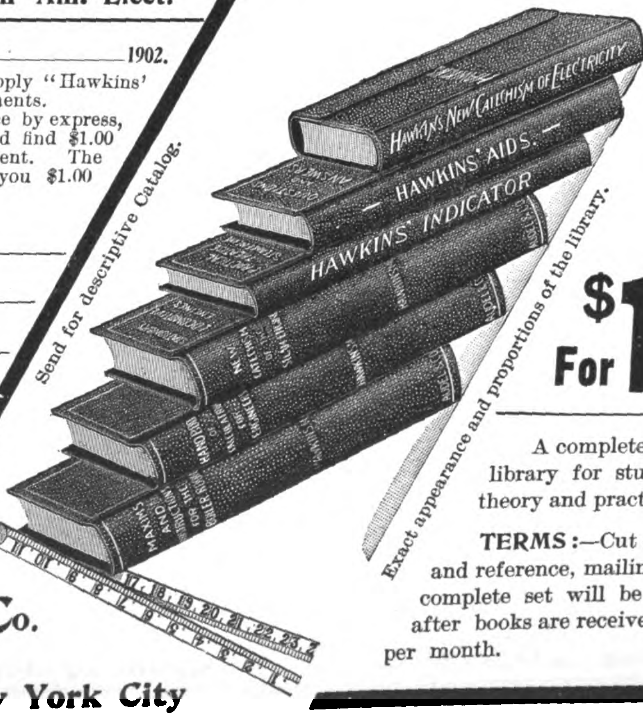
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American Electrician.

Vol. XIV. New York, August, 1902. No. 8.

RECONSTRUCTED CENTRAL STATION AND SUB-STATIONS.

PLANT OF THE NEW YORK & QUEENS ELECTRIC LIGHT & POWER COMPANY.

A short time ago the properties of the Electric Illuminating and Power Company, of Long Island City., L. I., the New York and Queens Gas and Electric Company, of Flushing, L. I., and the Jamaica Electric Light Company, of Jamaica, L. I., were consolidated under the name of the New York & Queens Electric Light & Power Company. The power house of the Electric Illuminating & Power Company was located on the East River at Astoria, L. I., and before the consolidation it contained one 500-kw., one 300-kw., and one 75-kw. alternating-current generators, the first two being Westinghouse two-phase 60-cycle machines with armature shafts direct-coupled to vertical compound Williams engines running at 150 r. p. m. The 75-kw. generator was a belt-driven General Electric machine. The station also contained eight 50-light T.-H. and two 80-light Brush arc dynamos, which were driven through a jack-shaft by two slow-speed horizontal Corliss-type engines.

The plant of the New York & Queens Gas & Electric Company was located on Flushing Creek, in Flushing, and was equipped with a 120-kw. two-phase generator belted to a Westinghouse three-cylinder gas engine, three 75-kw. two-phase 60-cycle alternators, three 75-light, one 90-light, and two 150-light Westinghouse arc machines belted direct to Westinghouse compound engines. Illuminating gas from the street mains was used in the gas engine, and the generator driven by it was operated in parallel with the three small alternators during the peak of the load.

The power house of the Jamaica Electric Light Company was situated at Dunton, a short distance outside of Jamaica, on the line of the Long Island Railroad, and contained twelve Ball arc machines ranging in capacity from 70 lights to 160 lights, belted to six Ames simple engines, one 150-kw. and one 50-kw. Stanley two-phase 133-cycle generators, belt-driven, for incandescent lighting and power purposes.

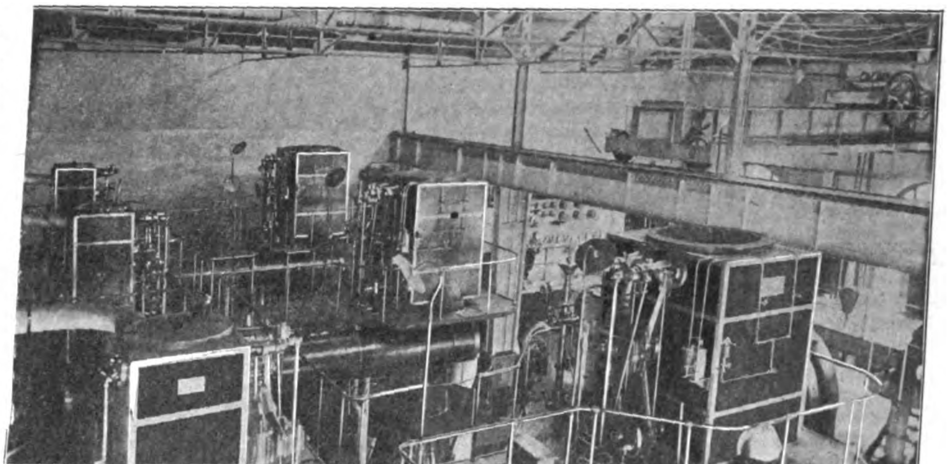

FIG. 2.—NEW GENERATING UNITS.

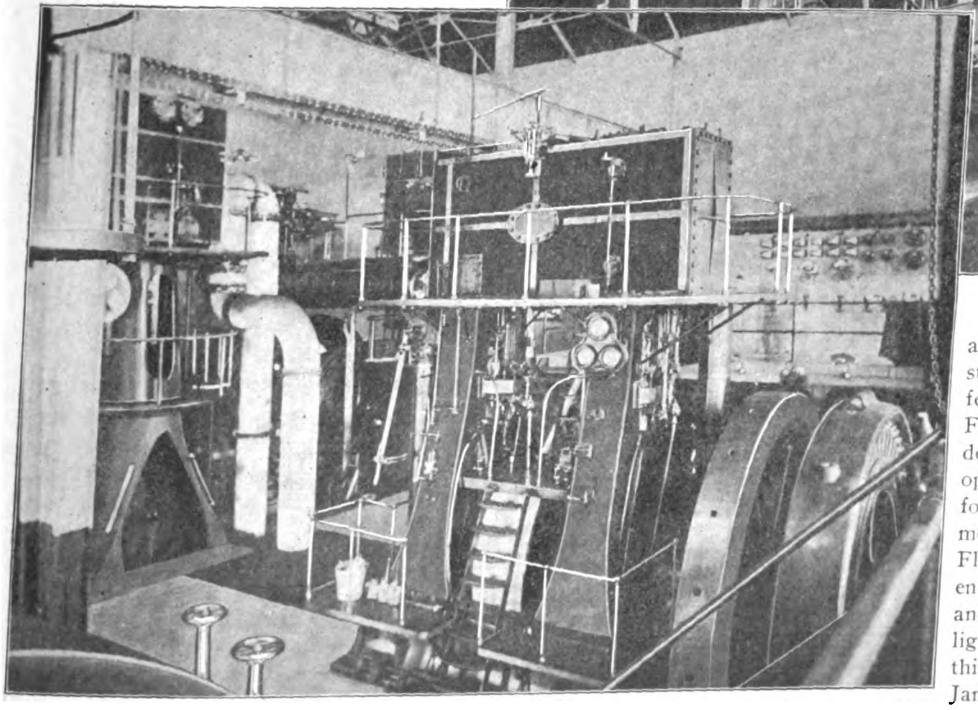

FIG. 1.—VIEW IN ENGINE ROOM, SHOWING ONE OF THE OLDER GENERATING UNITS.

The Astoria plant was of modern design and the building a substantial brick and steel structure, the engine room being 80 x 90½ feet and the boiler room 70 x 75⅓ feet. The Flushing and Jamaica plants were of inferior design and construction, and were being operated very uneconomically. The plans for reconstruction involved the abandonment of the steam generating stations at Flushing and Jamaica, and provided for the enlargement of the power plant at Astoria, and for the transmission of power for arc lights, incandescent lights and motors from this end to sub-stations in Flushing and Jamaica. The two small plants have therefore been replaced by sub-stations of modern design and construction. The old-style direct-current arc lamps used in Long Island City and Jamaica have been replaced by modern series alternating-current enclosed arc lamps, and the incandescent lighting and power systems of Jamaica changed from 133

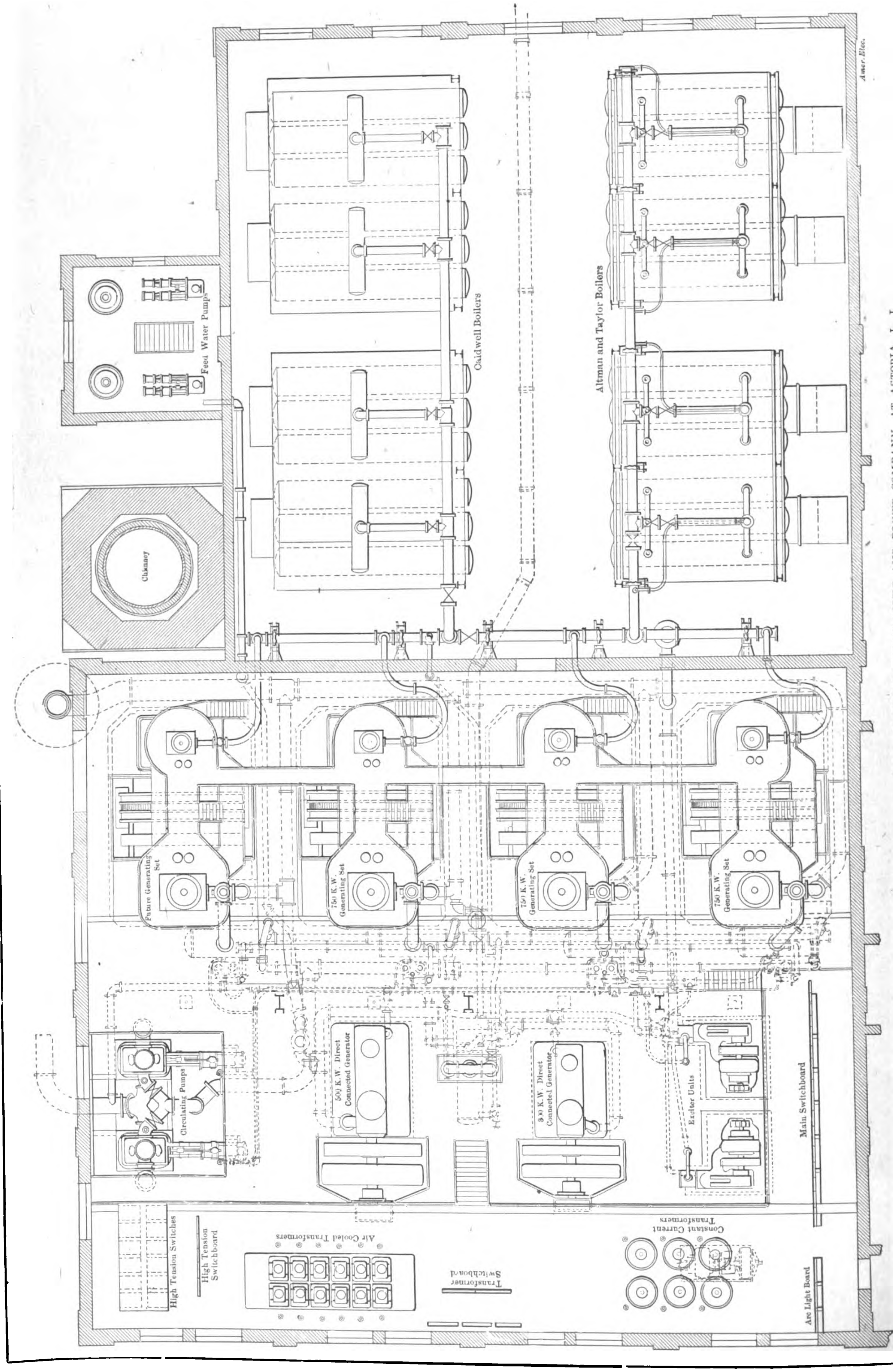
Feed Water Pumps
Chimney
Caldwell Boilers
Altman and Taylor Boilers
Future Generating Set
750 K.W. Generating Set
750 K.W. Generating Set
750 K.W. Generating Set
Circulating Pumps
500 K.W. Direct Connected Generator
500 K.W. Direct Connected Generator
Exciter Units
Main Switchboard
High Tension Switches
High Tension Switchboard
Air Cooled Transformers
Transformer Switchboard
Constant Current Transformers
Arc Light Board
Amer. Elec.

FIG. 3.—PLAN OF THE POWER HOUSE OF THE NEW YORK & QUEENS ELECTRIC LIGHT AND POWER COMPANY, AT ASTORIA, L. I.

cycles to 60 cycles, thus making all three systems uniform and of modern type.

Current is generated and distributed at Long Island City at 2200 volts, two-phase, and it is transformed by the Scott method to 7500 volts, three-phase, for transmission to the two sub-stations, where it is used at this pressure by General Electric constant-current transformers. For incandescent lighting and power purposes it is transformed back to 2200 volts, two-phase. Constant-current transformers in the main station are supplied at 2200 volts from the bus-bars, and raise this voltage to that necessary to operate 75 and 100 arc lamps in series.

The transmission e. m. f. of 6600 volts, with a maximum of 7500 volts on full load, was chosen because it was believed that much less difficulty would be experienced in gaining permission to operate at that voltage with inconspicuous glass insulators than if the line were operated at a higher potential with large white porcelain insulators. Moreover, since it was necessary to use a fairly large size of wire in order to obtain sufficient mechanical strength, and since the distance of transmission was comparatively short, the saving by operating at 10,000 volts would not have been as great as it might seem at first glance.

The generating station is admirably situated to obtain its supply of coal and condensing water at the lowest cost, and is located almost equidistant from the two sub-stations. The building was originally designed for several units of somewhat smaller capacity than those that have been installed, so that the reconstruction has only necessitated some slight changes in the structure to accommodate the new apparatus. The work of reconstruction, however, was difficult since it was necessary to make all the changes in the steam and electrical apparatus without interfering with the regular operation of the plant.

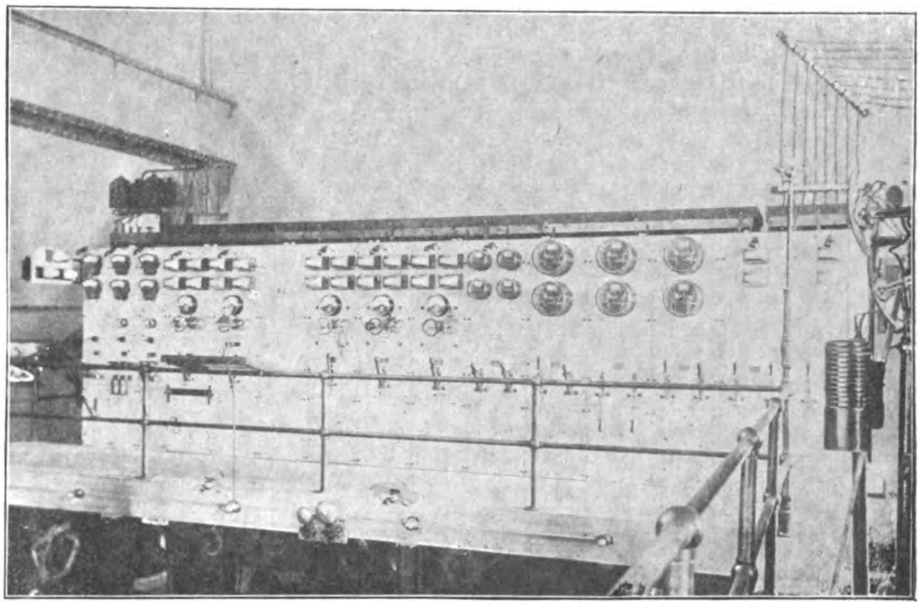

FIG. 5.—MAIN SWITCHBOARD AT ASTORIA.

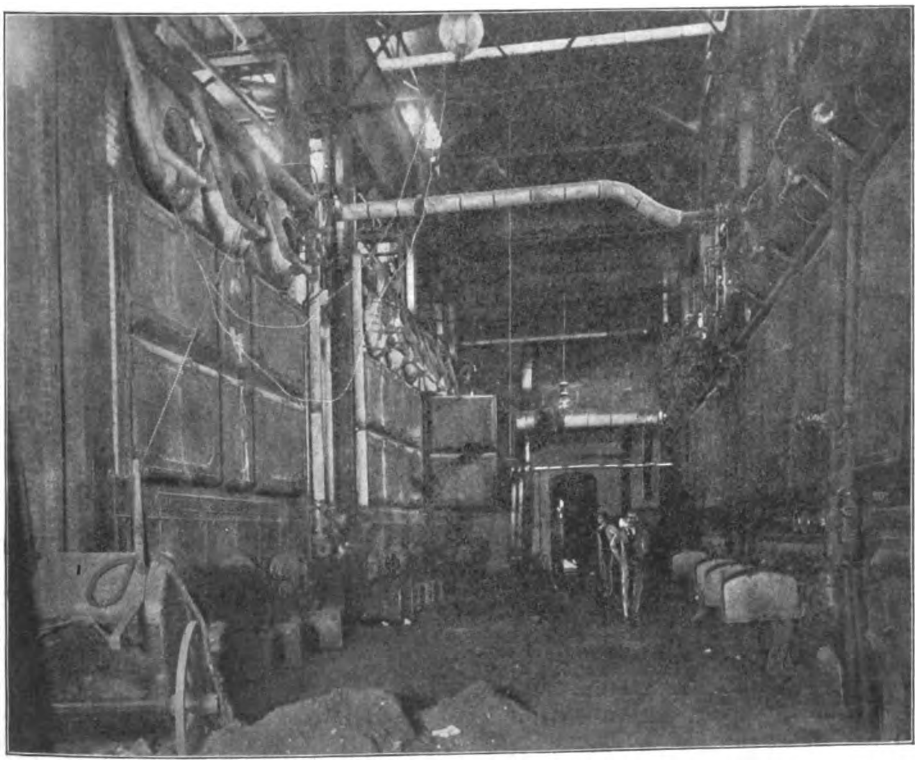

FIG. 4.—VIEW IN BOILER ROOM.

The two Corliss engines and jack-shafting of the original station have been replaced by three vertical cross-compound condensing engines, built by the Fulton Iron Works, of St. Louis, Mo., and direct-connected to 750-kw. Stanley alternators. The engines, which are shown by Fig. 2, are of the side-crank type, with the flywheel and generator mounted on the shaft between the frames. Each engine delivers to the generator 860 horse-power at its most economical load with a steam pressure of 140 pounds and 26 inches of vacuum, when running at 113 r. p. m., and is capable of developing 1200 indicated horse-power continuously, and a maximum of 1375 horse-power for a short period.

The engines and governors are so designed that when running at the same speed under any load between friction load and one-fourth overload, the amount of work done by each of the engines is practically equal to the amount of work done by each other engine in operation, and the maximum change in speed due to any instantaneous change in load of 225 indicated horse-power between friction load and one-fourth overload does not exceed 3 per cent. The governors permit the speed of each engine to be reduced from its rated speed of 113 r. p. m. to 5 per cent below, or increased to 5 per cent above while in operation.

The frame and bases and the general design of the engines are similar to the well-known Reynolds-Corliss vertical type. The cranks are in quadrature and are overhung. The main bearings are of the water-cooled removable-shell type. The cylinders are not steam jacketed, but their walls are sufficiently thick to provide for reboring twice or increasing their internal diameter three-fourths of an inch without rendering them unsafe or unfitted to perform the service required. The cylinders are 21 inches and 42 inches in diameter, respectively, with a stroke of 42 inches. The valve-gear is of the double-eccentric releasing Corliss type with the valves in the cylinder heads to reduce the clearance. The receivers are of the cylindrical re-heating type, supported by means of brackets on the high and low-pressure frames. The re-heating surface is composed of two-inch straight tubes expanded into bored tube seats, the heads being placed in the center section of the receiver. The exhaust from the high-pressure cylinder enters the receiver and passes through the inside of the re-heating tubes to the low-pressure cylinder, live steam surrounding the outside surface of the re-heating tubes. The engines are provided with two galleries, the upper ones being connected together so that the operators may pass directly from one unit to another.

Steam is supplied by four Caldwell horizontal water-tube boilers and three Altman & Taylor water-tube boilers, having a total nominal rating of 2900 horse-power. The boilers are set in batteries of two, and are hand-stoked with a mixture of washed culm and bituminous coal. Draft is furnished by a single brick stack 190 feet high and 9½ feet inside diameter, located in one corner of the boiler house. The feed-water pumps are located in the pump house built for the purpose, adjoining the boiler room. This room contains an 8 x 12 x 6 x 12 compound duplex outside-packed, plunger-type pump, built by the George F. Blake Manufacturing Company, and two 6 x 9 x 5¼ x 10 Worthington compound duplex pumps of the piston type. The room also contains two 1500-h.p. Goubert feed-water heaters, which utilize the exhaust steam from the auxiliaries for heating the feed-water.

Each of the new engines is equipped with an independent condenser set composed of a Wheeler "Admiralty" surface condenser and a steam-driven Blake vertical twin-beam air pump. The condenser is of the rectangular pattern with a cast-iron shell. The tube-heads are of bronze and the tubes are of seamless drawn brass tinned inside and out, and held in place in the tube-heads by screw glands in order to provide for expansion and contraction. The air cylinders are provided with solid bronze buckets and rods,

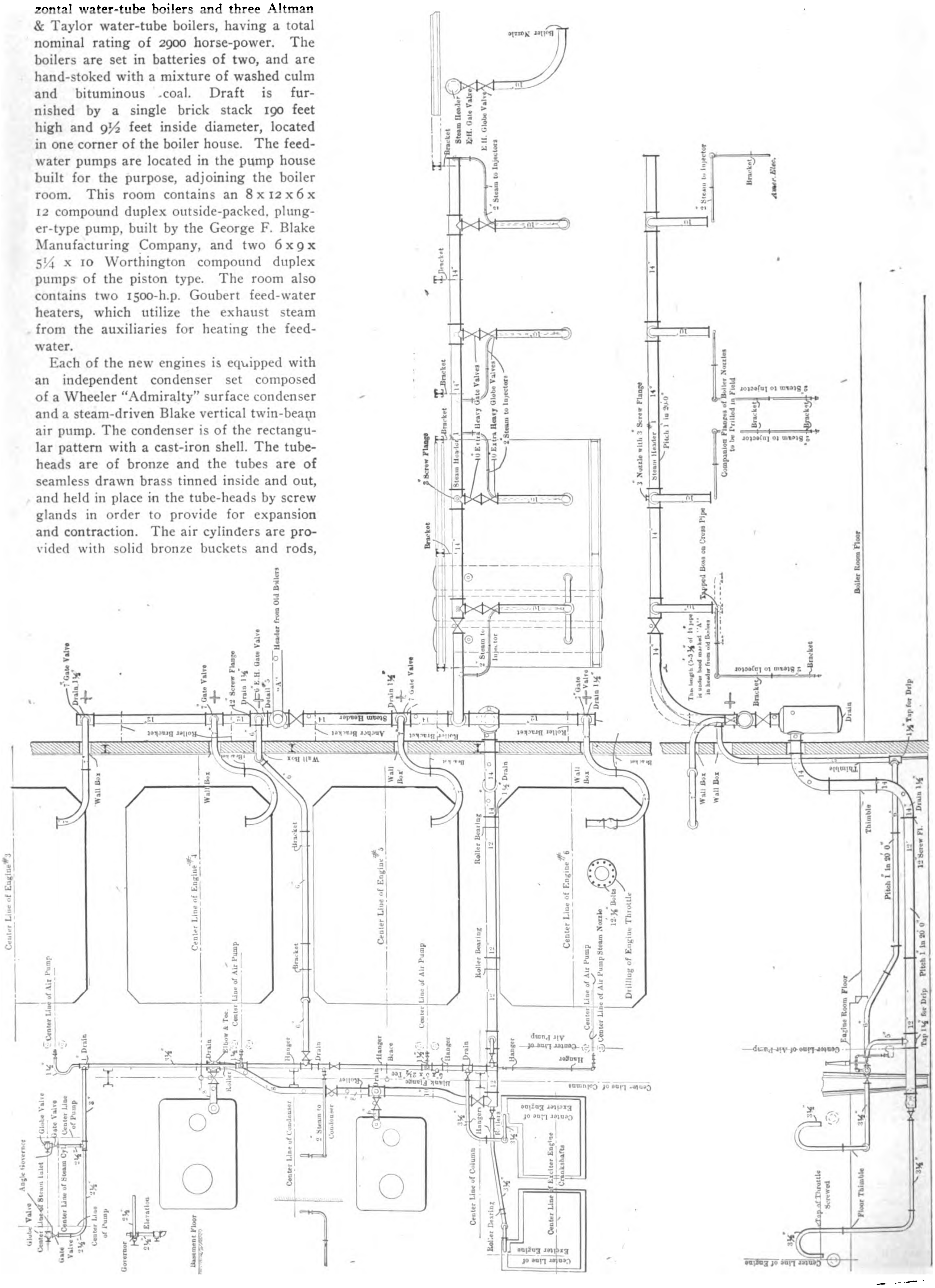

FIG. 6.—COMPLETE DIAGRAM OF STEAM PIPING.

and contain three valve decks. The steam cylinders are supported in a line directly over the air cylinders by a cast-iron entablature, to which they are bolted; also by steel columns from the tops of the air cylinders. The valve-gear is of the well-known simplex type, capable of adjustment for length of stroke while the pump is running. It is proposed to use the water of condensation for boiler feed, together with such additional supply from the city mains as may be required to make up the usual losses. The condenser for the two old units is also of Wheeler manufacture and is placed between the engines.

The circulating pumps are situated in the basement, and the engine-room floor is left open above them. The plant is equipped with two Blake horizontal tandem-compound circulating pumps, each having a high-pressure steam cylinder of 14 inches, a low-pressure cylinder of 20 inches, and a water cylinder of 30 inches diameter, the stroke of all being 24 inches. These pumps are adapted for handling salt water; that is to say, they are provided with composition plates for both suction and discharge valves, which

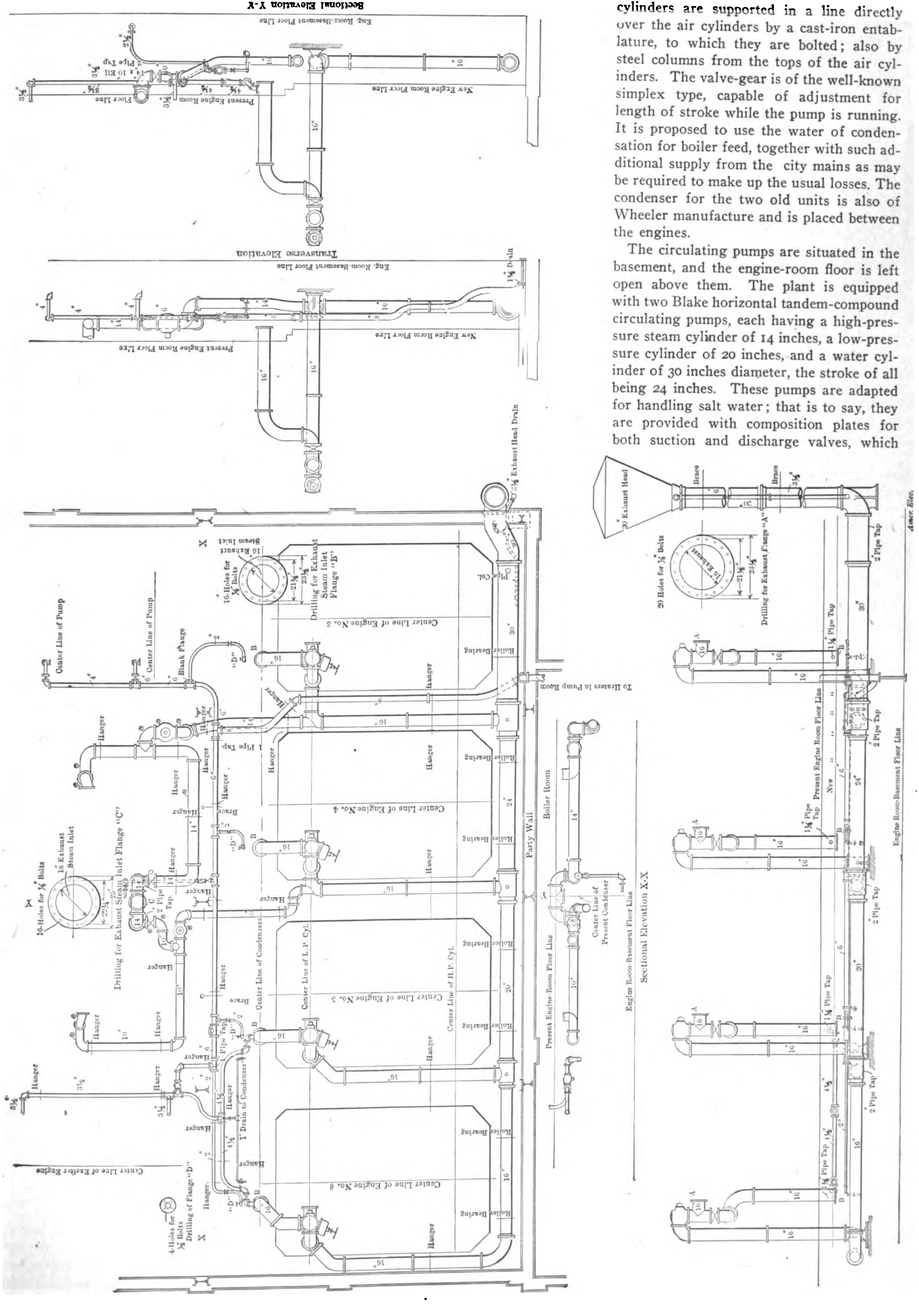
Sectional Elevation Y-Y
Eng. Room-Basement Floor Line
New Engine Room Floor Line
Present Engine Room Floor Line
Transverse Elevation
1½" Drain
2½" Exhaust Head Drain
Center Line of Pump
Blank Flange
To Heaters in Pump Room
Center Line of Engine No. 3
Center Line of Engine No. 4
Center Line of Engine No. 5
Center Line of Engine No. 6
Center Line of Condensers
Center Line of L. P. Cyl.
Center Line of H. P. Cyl.
Center Line of Exciter Engine
16 Exhaust Steam Inlet
16-Holes for ⅞" Bolts
Drilling for Exhaust Steam Inlet Flange "B"
18 Exhaust Steam Inlet
Drilling for Exhaust Steam Inlet Flange "C"
4-Holes for ⅝" Bolts
Drilling of Flange "D"
1" Drain to Condenser
Hanger
Brace
Roller Bearing
Pipe Col.
Party Wall
Boiler Room
Center Line of Present Condenser
Present Engine-Room Floor Line
Engine Room-Basement Floor Line
Sectional Elevation X-X
30" Exhaust Head
Brace
20 Holes for ⅞" Bolts
16 Exhaust
Drilling for Exhaust Flange "A"
2 Pipe Tap
1¼ Pipe Tap
Present Engine Room Floor Line
New
Engine Room-Basement Floor Line
X
Amer. Elec.

FIG. 7.—PLAN, ELEVATION AND DETAILS OF EXHAUST PIPING.

project through and beyond the flanges of the main casting. This is a feature of these pumps, it being common to screw or drive brass seats into iron castings, and these sooner or later become loose, owing to the corroding influence of the salt water. The water cylinder of each pump has a special lining which extends from head to head, the ports being cut through the lining. The steam cylinders are in tandem in one casting, and the piston-rods are arranged so that there is no inconvenience in getting at either the high or the low-pressure pistons, or in packing the piston-rod stuffing boxes. The low-pressure piston has two rods which pass through sleeves cast on the sides of the high-pressure cylinder, thereby doing away with inside stuffing boxes. The stuffing boxes are on the ends of these sleeves on a line with the stuffing box of the piston of the high-pressure cylinder. By this arrangement the three stuffing boxes are outside of the lagging and thus very convenient for repacking. The two low-pressure rods and the high-pressure rod, as well as the pump rods, connect to a common cross-head. The valve-gear is of the simplex type. Heavy polished steel rods connect the steam and water ends. The pumps are run non-condensing, the exhaust passing through two 1,500-hp. Goubert feed-water heaters.

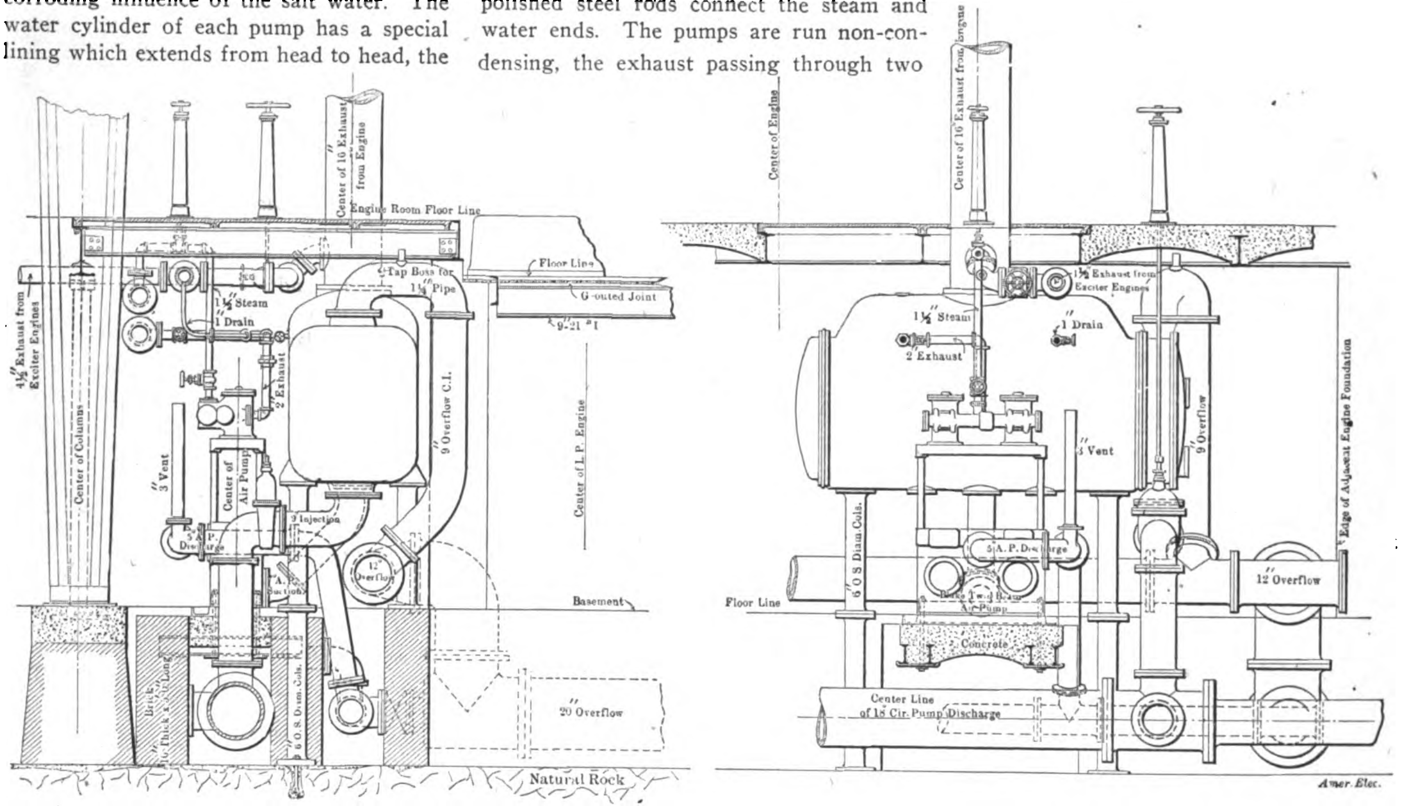
Center of 10" Exhaust from Engine
Engine Room Floor Line
Tap Boss for 1¼" Pipe
Floor Line
Grouted Joint
9'-2½"
4½" Exhaust from Exciter Engines
1½" Steam
1" Drain
2" Exhaust
Center of Columns
3" Vent
Center of Air Pump
9" Injection
5" A. P. Discharge
A. P. Suction
12" Overflow
9" Overflow C.I.
Center of L. P. Engine
Basement
Brick 16" Thick
6" O.S. Diam. Cols.
20" Overflow
Natural Rock
Center of Engine
Center of 16" Exhaust from Engine
1½" Exhaust from Exciter Engines
1½" Steam
1" Drain
2" Exhaust
3" Vent
9" Overflow
Edge of Adjacent Engine Foundation
6" O S Diam. Cols.
5" A. P. Discharge
12" Overflow
Floor Line
Twin Beam Air-Pump
Concrete
Center Line of 18" Cir. Pump Discharge
Amer. Elec.

FIG. 8.—VIEWS SHOWING ARRANGEMENT OF CONDENSER AND CONNECTIONS.

Fig. 2 is a plan view of the Astoria plant, showing the arrangement of the apparatus. It will be seen that provision for one more unit has been made. The new engines and generators are placed in a row along the division wall, and the old units are situated in the two center bays opposite them; one of the remaining bays is occupied by two 50-kw. engine-driven, and one 40-kw. motor-driven, exciting units. The engine-driven exciter generators were furnished by the Bullock Electric Manufacturing Company, and the engines by the Harrisburg Foundry and Machine Works, Harrisburg, Pa.; the motor-driven set was furnished by the Westinghouse Company. One of the engine-driven exciters is shown by Fig. 9.

The boilers are placed in two rows at right angles to the line of the engines, the Caldwell boilers occupying one side of the boiler room and the Altman & Taylor boilers the other. This arrangement was fixed at the time of the original construction of the station. The flue is controlled by a Locke damper regulator, and is divided into two sections, each having an opening

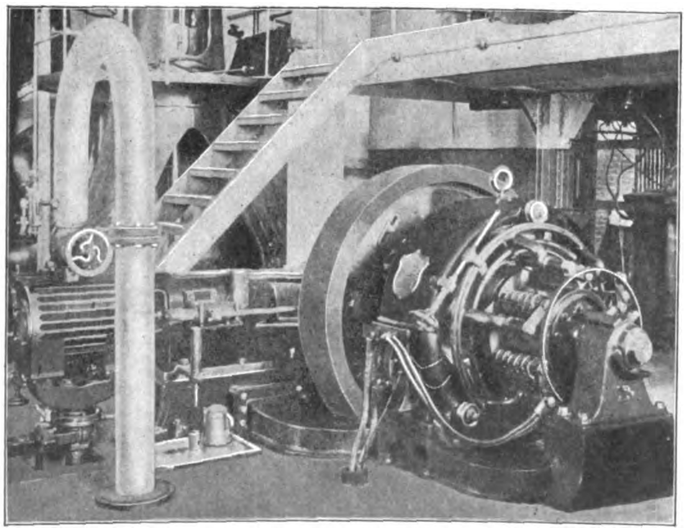

FIG. 9.—ONE OF THE EXCITER UNITS.

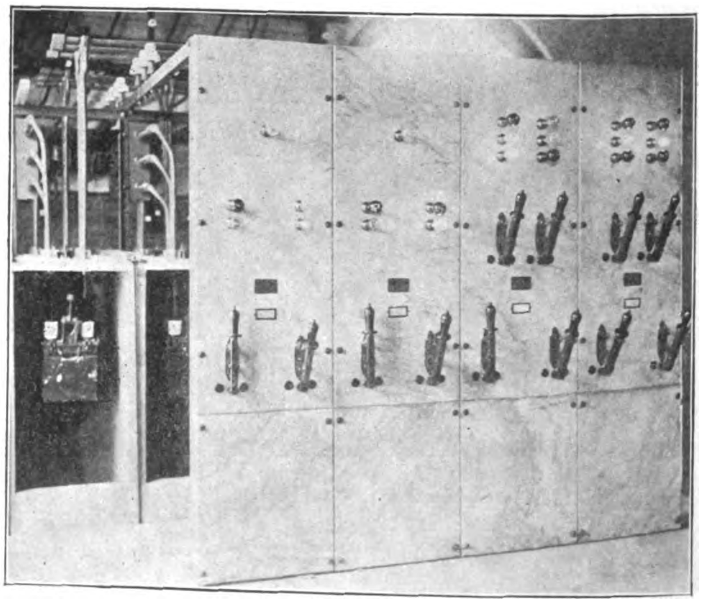

FIG. 10.—HIGH-TENSION SWITCHBOARD AT ASTORIA.

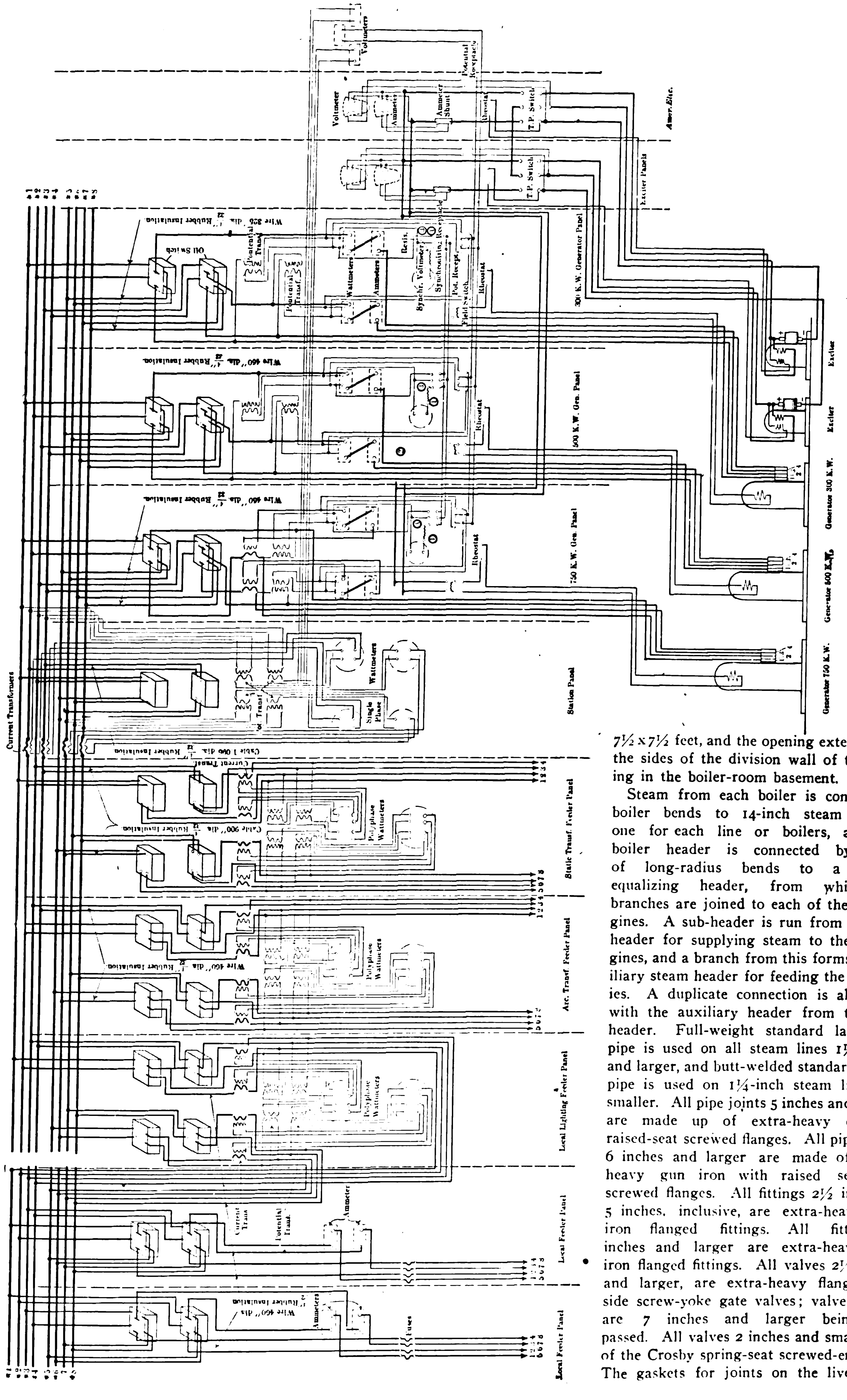
Voltmeters
Voltmeter
Ammeter
Ammeter Shunt
Potential Receptacle
Rheostat
T.P. Switch
T.P. Switch
Amer. Elec.
Exciter Panels
Wire 826″ dia. ¼″ Rubber Insulation
Oil Switch
Potential Transf.
Wattmeters
Ammeters
Resis.
Synchr. Voltmeter
Synchronizing Receptacle
Pot. Recept.
Field Switch
Rheostat
300 K.W. Generator Panel
Exciter
Exciter
Wire 460″ dia. ¼″ Rubber Insulation
500 K.W. Gen. Panel
Generator 300 K.W.
Wire 460″ dia. ¼″ Rubber Insulation
750 K.W. Gen. Panel
Generator 500 K.W.
Generator 750 K.W.
Current Transformers
Wattmeters
Single Phase
Station Panel
Cable 1 000 dia. ¼″ Rubber Insulation
Current Transf.
Cable 900″ dia. ¼″ Rubber Insulation
Polyphase Wattmeters
Static Transf. Feeder Panel
Wire 400″ dia. ¼″ Rubber Insulation
Polyphase Wattmeters
Arc. Transf. Feeder Panel
Polyphase Wattmeters
Local Lighting Feeder Panel
Current Trans.
Potential Trans.
Ammeter
Local Feeder Panel
Wire 400″ dia. ¼″ Rubber Insulation
Ammeters
Fuses
Local Feeder Panel

FIG. 11.—DIAGRAM OF CONNECTIONS ON MAIN SWITCHBOARD.

7½ x 7½ feet, and the opening extends along the sides of the division wall of the building in the boiler-room basement.

Steam from each boiler is conveyed by boiler bends to 14-inch steam headers, one for each line or boilers, and each boiler header is connected by means of long-radius bends to a 14-inch equalizing header, from which two branches are joined to each of the new engines. A sub-header is run from the main header for supplying steam to the old engines, and a branch from this forms an auxiliary steam header for feeding the auxiliaries. A duplicate connection is also made with the auxiliary header from the main header. Full-weight standard lap-welded pipe is used on all steam lines 1½ inches and larger, and butt-welded standard-weight pipe is used on 1¼-inch steam lines and smaller. All pipe joints 5 inches and smaller are made up of extra-heavy cast-iron raised-seat screwed flanges. All pipe joints 6 inches and larger are made of extra-heavy gun iron with raised seat and screwed flanges. All fittings 2½ inches to 5 inches, inclusive, are extra-heavy cast-iron flanged fittings. All fittings 6 inches and larger are extra-heavy gun-iron flanged fittings. All valves 2½ inches and larger, are extra-heavy flange, outside screw-yoke gate valves; valves which are 7 inches and larger being by-passed. All valves 2 inches and smaller are of the Crosby spring-seat screwed-end type. The gaskets for joints on the live steam lines are made of corrugated copper. The gun iron used in the flanges and fittings was tested for a tensile strength of 27,000 pounds per square inch. The exhaust and water piping is composed in general of standard cast-iron pipe with joints made up with Rainbow gaskets.

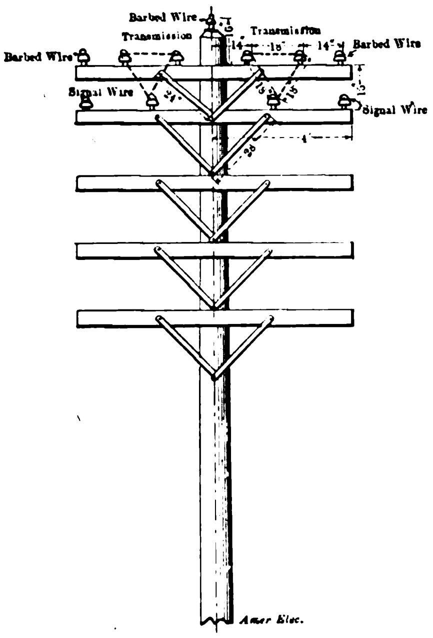

FIG. 12.—TRANSMISSION LINE POLE.

The heavy steam drains from the headers and engine receivers are collected and returned to the boilers by the Holly gravity return system. Each independent drain is connected to a header that discharges into the Holly receiver, and is also by-passed into a low-pressure drain header, which discharges into the river, thus providing means for repairing the Holly header if required. The low-pressure drains from the exhaust piping, shells of engine receivers and blow-offs from cylinders are piped to the header which discharges into the river.

The feed and boiler blow-off lines are made of wrought-iron pipe with extra-heavy fittings and gate valves, in accordance with the specifications for material for live-steam piping. The entire piping installation was furnished and erected by the Best Manufacturing Company, Pittsburg.

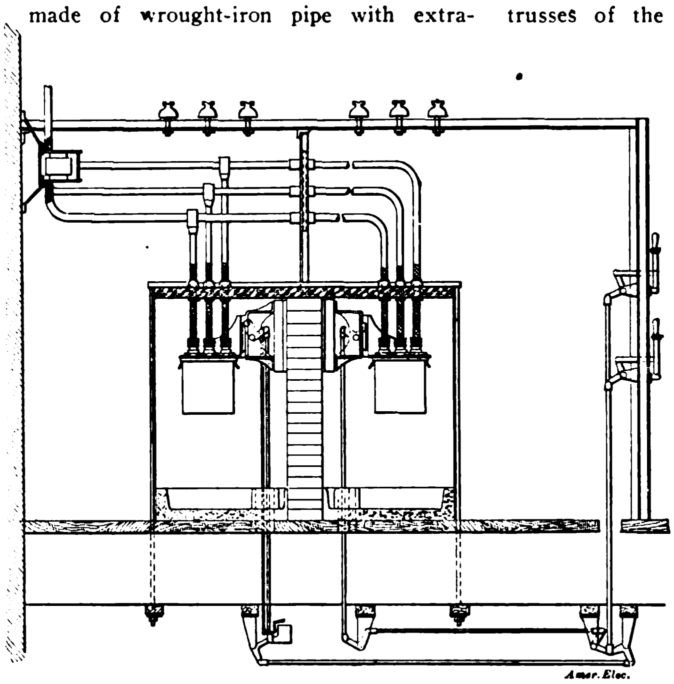

FIG. 13.—ARRANGEMENT OF HIGH-TENSION SWITCHES.

The plant is equipped with a gravity oiling system whereby oil is available under pressure to each oil cup of the engines, thus insuring good lubrication. The system consists of a large storage tank for receiving and storing oil drained from the filter and such additional new oil as is required. From this tank it is pumped by a small pump to a gravity tank located in the roof trusses of the boiler room. From this gravity tank a 2-inch supply is piped to the basement and runs by each new engine. From the supply pipe branches are piped to the oil cups of each engine. The oil, as it drains from the various journals of the engines, is collected in the crank pits, which are piped to a draining system which discharges into a 600-gallon Turner oil filter situated in the basement, where the oil is filtered and pumped again into the oil storage tank.

The switchboards and transformers are located on a gallery extending along the front wall of the building. The generator board is placed on a wing leading from the main gallery and contains one motor- and two engine-driven exciter panels, five generator panels, one station panel, one transformer feeder panel, one arc-light feeder panel, one local feeder panel, and two local distribution panels. Fig. 5 shows the board and Fig. 11 is a diagram of the connections.

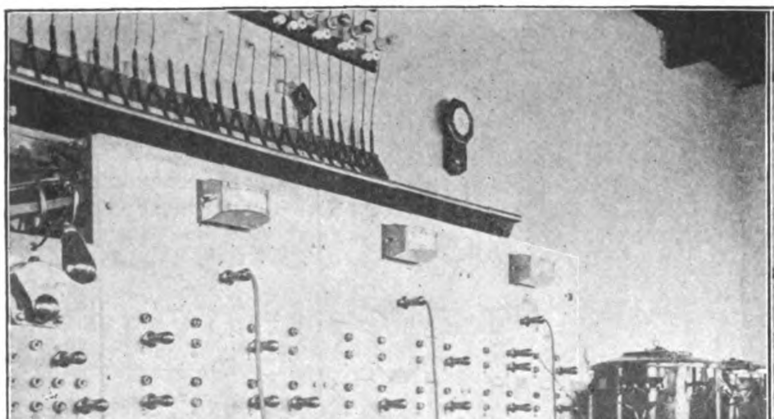

FIG. 14.—ARC SWITCHBOARD AT JAMAICA.

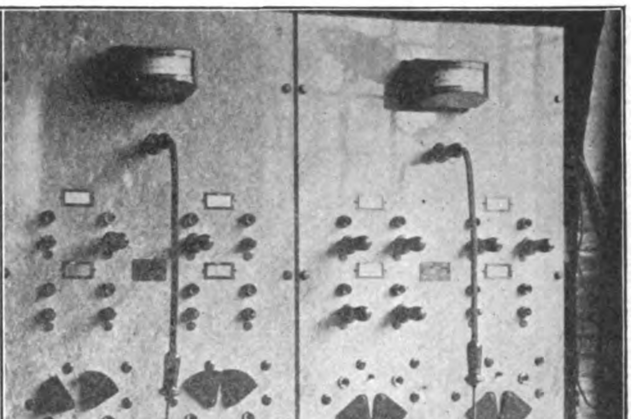

FIG. 15.—ARC BOARD AT ASTORIA.

The diagram shows but one 750-kw. generator panel, but there are three of these, the wiring, of course, being identical. Each of the generator panels contains two indicating wattmeters and ammeters. The station panel has four single-phase recording wattmeters, and each of the feeder panels is equipped with two polyphase recording wattmeters; and a swinging bracket at the end of the board carries three voltmeters, two of which are connected to the two sets of bus-bars, and the third may be plugged on to either phase of any generator.

The arc-light board, which is on a line with the main board and separated from it, is shown by Fig. 15. It contains two eight-circuit panels, each providing control for four arc-light regulators. The connections are so arranged that the board may be fed from the duplicate set of bus-bars, and any transformer may be connected to any set of bus-bars. Near the center of the main gallery is connected a two-panel switchboard for controlling the primary side of eight 200-kw. air-blast step-up transformers, which raise the voltage from 2200 to 7500 for transmission. The secondary pressure may be varied from 6600 volts to 7500 volts in four steps by changing the connections to the taps on the primary side. The air-blast apparatus has been installed in duplicate, and a spare transformer provided, so that no interruption to the circuits may be caused by failure of any part of the transforming apparatus. The secondaries of the transformer and transmission lines, which are in

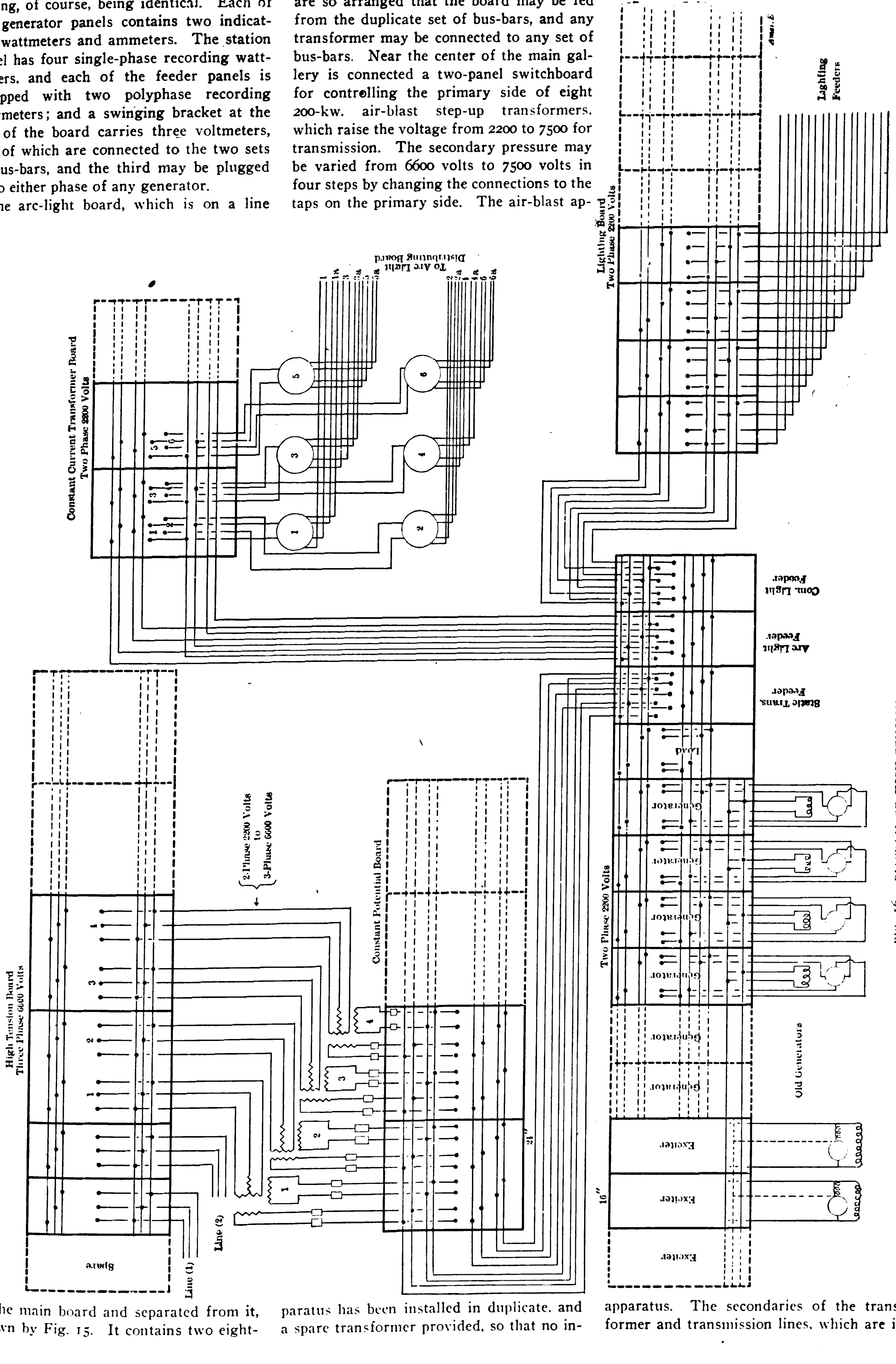
Constant Current Transformer Board
Two Phase 2200 Volts
To Arc Light
Distributing Board
1
2
3
4
5
6
Lighting Board
Two Phase 2200 Volts
Lighting
Feeders
Com. Light
Feeder
Arc Light
Feeder
Static Trans.
Feeder
Load
Generator
Generator
Generator
Generator
Generator
Generator
Old Generators
Exciter
Exciter
Exciter
Two Phase 2200 Volts
16"
21"
Constant Potential Board
2-Phase 2200 Volts
to
3-Phase 6600 Volts
High Tension Board
Three Phase 6600 Volts
Spare
Line (1)
Line (2)

FIG. 16.—DIAGRAM OF HIGH-TENSION SWITCHBOARD WIRING.

duplicate, are controlled by a four-panel switchboard located at one end of the main gallery.

The transformers are used in pairs for transforming 60-cycle two-phase currents to three-phase currents for transmission, and *vice versa*. The step-up transformers deliver 200 kilowatts to the three-phase transmission line at a potential of 7500 volts between line wires, the primary side of the transformers being supplied with current at a potential of 2200 volts and the power factor being .80. The step-down transformers deliver 100 kilowatts to a two-phase circuit at a potential of 2100 volts when the primary is supplied with current at a potential of 6600 volts, the power factor being .80.

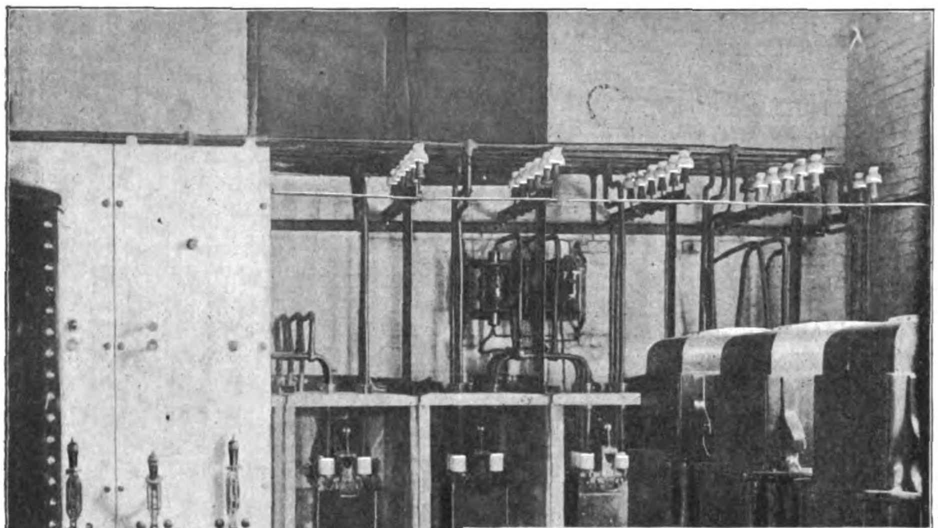

FIG. 17.—HIGH-TENSION BOARD AND EQUIPMENT AT FLUSHING.

The transformers are capable of operating continuously at full load for twenty-four hours without heating over 40° C. above the temperature of the surrounding air. They are also capable of carrying one-fourth overload for two hours without heating more than 50° C. above the temperature of the surrounding air, and of taking a 50 per cent overload momentarily without injury. When supplying a load with a power factor of .80 the efficiencies of the transformers vary from 98 per cent at full load to 94 per cent at quarter-load. The drop in secondary voltage from no load to full load is less than 4 per cent.

Means are provided for connecting the step-up transformers so that the transformed voltage may be made 6600, 6800, 7000 7250 or 7500, by changing connections on the low-pressure side. The insulation resistance between the high-pressure windings and the core, as well as that between the high and low-pressure windings, is sufficient to withstand 15,000 volts from a source of alternating current having a capacity of 25 kilowatts. The low potential winding withstands a similar test with current at a potential of 5000 volts. Both of the windings have an insulation resistance between themselves and the core of one-half megohm. The transformers are designed to operate in multiple and to divide the load evenly. The two-phase induction regulators used to regulate the circuits leading from the step-down transformers are capable of raising or lowering the potential of these transformers 10 per cent. These regulators are operated by hand wheels.

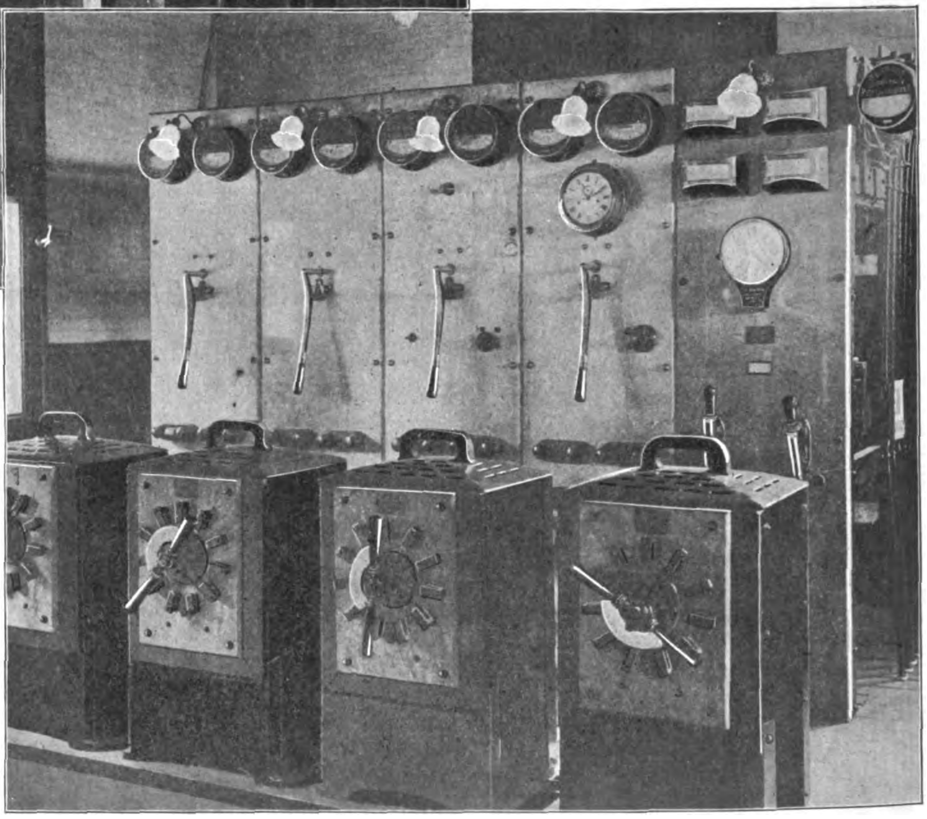

FIG. 18.—DISTRIBUTION BOARD AT FLUSHING.

General Electric oil switches are used throughout. Those for controlling the two-phase circuits are each two-pole double-throw, two of them being operated by one handle, thus forming virtually a four-pole double-throw switch. They are mounted one above the other on the walls of the building back of the switchboard, and the operating handles are mounted on the front of the panels. The three-phase high-tension switches are placed in brick compartments and located in two rows back to back on the gallery behind the high-tension board, as shown by Fig. 13. The transformers are protected by fuses in the primary circuits, and the transmission lines are equipped with overload relays, which trip the high-tension switches if any overload or short-circuit occurs on the line. The bus-bars are in duplicate throughout, and a signal system has been installed at the main and sub-stations which prevents two sets of bus-bars from being paralleled at any point excepting at the main board.

The signaling is done by vari-colored incandescent lamps mounted over each switch on the high-tension board, and so connected that when a switch on the primary side of the transformers is operated the lamp indicates the proper secondary switch to be thrown. A signaling system is also provided on the high-tension transmission line. This consists of an incandescent lamp at each end of the line supplied through a small transformer and so connected as to light when the circuit is thrown on, thereby indicating to the switchboard attendant that the line is in working order and alive. Fig. 16 is a diagram of the high tension wiring.

The transmission line consists of two three-phase circuits. No. 0, insulated copper wire being used from the power house to a point two and one-half miles distant, where each circuit branches off to the sub-stations. The line to Jamaica extends 7 miles from the junction point, and the two circuits are made up of No. 3 insulated wire. The line to Flushing is three and three-quarter miles from the junction, and

No. 4 wire is used, making a total of fifteen and three-quarter miles of transmission line. The lines are supported by 45-foot chestnut poles placed 100 feet apart along the highway. The wires are carried 18 inches apart on 4½-inch triple-petticoat glass insulators and are supported in triangular position by two 8-foot cross-arms. The line is protected from lightning by three galvanized barbed wires, one supported at each end of the upper cross-arm by pony glass insulators and the third carried on the top of the pole, as shown by Fig. 12, by an insulator on an iron ridge pin. All three barbed wires are grounded at every fifth pole by No. 6 galvanized wire, which is protected from mechanical injury at the base of the pole by a quarter-inch gas pipe. The transmission wires are properly transposed at intervals to avoid inductive interference. The cross-arms are made of Georgia pine thoroughly creosoted. Two arms are provided to carry the transmission circuits and the barbed wires, the upper one being a special six-pin arm and the lower one a standard eight-pin arm. Cross-arms are provided below the transmission arms so that secondary or arc circuits can be run below the transmission wires. One wire of a single line is carried at each end of the lower cross-arm. The transmission lines are carried through Flushing Creek by two No. 0, 10,000-volt submarine cables, and a subway conducts them to the Flushing sub-station.

The sub-stations are fireproof brick structures, each containing a high-tension switchboard, a 2200-volt transformer and feeder board, and a switchboard for controlling the arc-lighting apparatus. The high-tension board consists of two line panels and one primary transformer panel. The high-tension oil switches are in brick compartments arranged along the wall behind the high-tension panels. The feeder board in the Flushing sub-station is made up of a transformer panel for controlling the secondary side of the step-down transformers, and three feeder panels. The arc board is fed by two sets of three-phase bus-bars at the transmission pressure, and four arc-light transformers are controlled from each panel. The Flushing sub-station also contains five 100-kw. air-blast transformers, one being used as a reserve, which are provided with duplicate sets of blowing apparatus located in the basement. Four 10-kw. regulators are connected in the transformer secondaries, and two 100-light and four 75-light constant-current transformers are arranged in two rows in the center of the room. The Jamaica sub-station contains four 50-kw. oil-cooled transformers and four 6-kw. potential regulators. There are also installed four 100-light and nine 75-light arc-light transformers. A view of the interior of these sub-stations is given by Figs. 14, 17 and 18.

The engineers for the entire equipment were J. G. White & Co., of New York, to whom we are indebted for much of the information herein contained; and we are also under obligations to the 2nd vice-president and general manager of the New York & Queens Electric Light & Power Company, Mr. J. N. Bissell, for courtesies extended.

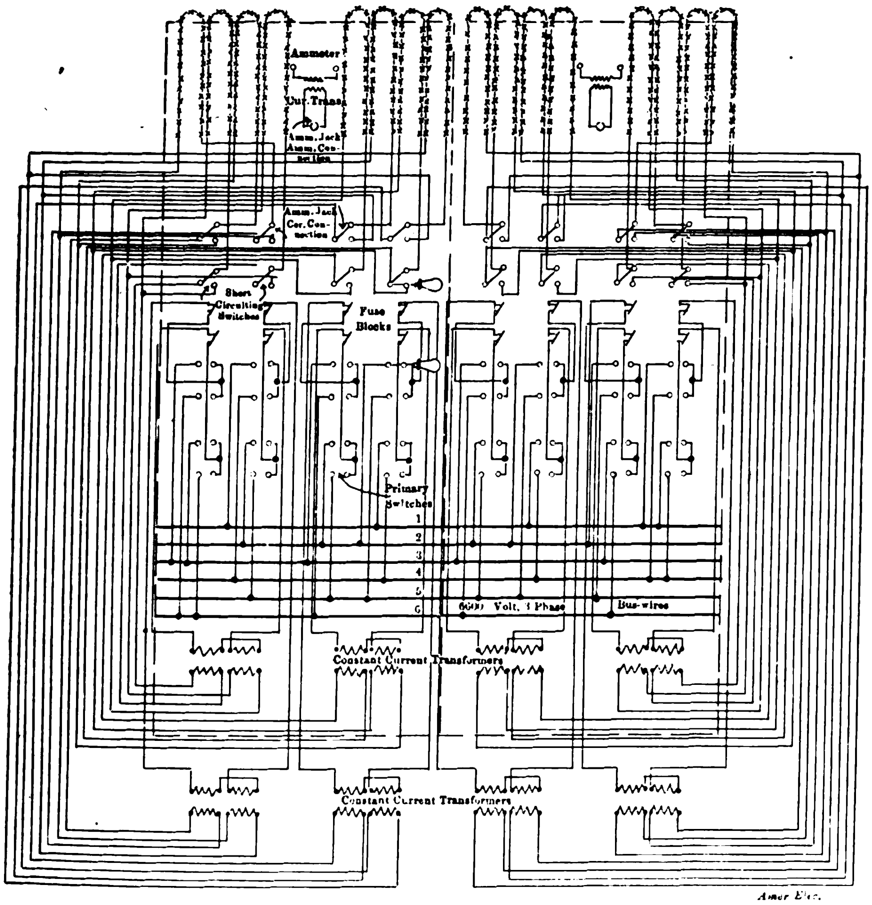

FIG. 19.—DIAGRAM OF TRANSFORMER WIRING.

CONDENSING VS. EXHAUST STEAM HEATING

BY CHARLES L. HUBBARD.

Cases often come up where a factory engine is run non-condensing and the exhaust steam turned into the heating system, where it is utilized toward warming the building in winter time. When this is done it is necessary to put a back pressure of 3 to 5 lbs. gauge upon the engine, in order to secure a proper circulation of steam through the radiators and coils. Sometimes a pressure as high as 8 or 10 lbs. is necessary in old and poorly piped heating plants. The question often arises in instances of this kind, will it pay to install a condenser and use live steam from the boilers for heating purposes? Here, again, everything depends upon the existing conditons, such as cost of coal and water, proportion of the year when heat is required, the relation of the exhaust steam to the whole amount required for heating, the type and cut-off of engine, etc. This can best be taken up in the form of a practical example and assuming possible conditions, then changing these conditions to meet actual requirements in different cases as they present themselves.

Assume the case of a factory which is to be supplied with power from an 18-in. x 42-in. non-condensing engine running at 150 revolutions, cutting off at one-fourth stroke and having a clearance of 9%; the boiler pressure being 95 lbs. gauge. The question is, which will be the more economical: to impose 5 lbs. back pressure on the engine and use the exhaust steam in the heating system or to install a condenser and heat the building with live steam from the boilers? Suppose the water rate of the engine non-condensing to be 30 lbs. per horse-power per hour, the rate of evaporation of the boilers 9 lbs. of steam per lb. of coal, the cost of coal $3 per ton, and condensing water to be available from a river free of cost, the only expense being that necessary to pump it from the river to the condenser; further, assume the distance and height to be such that it requires an expenditure of 500 foot-pounds per gallon to accomplish this, and that steam is required six months in the year to supply 24,000 sq. ft. of direct radiation. The cost of installation of pumps and condenser will be neglected, and fuel expenses only will be considered.

Consider first the case of heating with exhaust steam. From Table II, the ratio for one fourth cut-off and 9% clearance is .646, and assuming a back pressure of 5 lbs. gauge, the mean effective pressure will be $(95 + 15) \times .646 - 20 = 51$ lbs., making the indicated horse-power of the engine

$$\begin{array}{cccc} P & L & A & N \end{array}$$
$$\frac{51 \times 3.5 \times 254 \times 300}{33,000} = 412 \text{ i. h. p.}$$

The weight of steam required will be $412 \times 30 = 12,360$ lbs. per hour, and the weight of coal $12,360 \div 9 = 1373$ lbs., so that the cost of coal at $3 a ton will be $2.05 an hour.

For an engine of this type and cut-off a cylinder condensation of about 20% may be assumed, which will leave 12,360×.80= 9888 lbs. of steam per hour for heating purposes. Part of this can be used for heating the feed water. The temperature of steam at 5 lbs. gauge pressure is 228 degrees, and its latent heat is 954 heat units.

TABLE I.
Terminal Pressure Ratios.

	Per Cent.	Clearance.				
Cut-Off	0	1.75	3	5	7	9
1-10	.1	.115	.126	.143	.159	.174
1-8	.125	.14	.150	.167	.182	.197
1-6	.167	.161	.191	.206	.221	.235
1-5	.2	.214	.223	.238	.252	.266
1-4	.25	.263	.272	.286	.299	.312
5-16	.312	.324	.332	.345	.357	.369
1-3	.333	.344	.353	.365	.377	.388
3-8	.375	.386	.392	.405	.416	.427
2-5	.4	.410	.417	.428	.439	.449
7-16	.437	.447	.454	.464	.474	.484
1-2	.5	.509	.514	.524	.533	.541
5-8	.625	.632	.636	.643	.649	.656
3-4	.75	.754	.755	.762	.766	.771
4-5	.8	.804	.806	.809	.813	.816
9-10	.9	.902	.903	.905	.906	.908

To find the (theoretical) absolute terminal pressure, multiply the absolute initial pressure by the number opposite the given cut-off and in the column corresponding to the percentage of clearance.

If the feed water is to be heated from 70 to 210 degrees, it will require (210 — 70) × 12,360 = 1,730,400 heat units per hour, or will condense 1,730,400 ÷ 954 = 1814 lbs. of steam. This leaves 9888—1814 = 8074 lbs. of steam for radiator service. One square foot of direct radiating surface will condense about one-third of a pound of steam per hour, therefore, 24,000 sq. ft. will condense 24,000 × ⅓ = 8000 lbs. per hour, which leaves a surplus of 74 lbs. of steam to be exhausted outboard. This makes the full expense $2.05 per hour for power and heat. As the surplus steam would be wasted during the summer, the fuel expense would be uniform throughout the year.

For comparison it is necessary now to find what the saving in fuel for power would be by the use of a condenser. The first step is to find the required cut-off to give the same power as in the foregoing example with the reduced back pressure.

$$(95 + 15) \times R - 3 = 51, \text{ from which}$$

$$110\,R - 3 = 51 \text{ or } R = \frac{51 + 3}{110} = .49.$$

Looking in the table of ratios it is found that this ratio corresponds approximately to 1-7 cut-off, which may be taken as the new point. The saving in steam per stroke will then be

$$(\tfrac{1}{4} - 1\text{-}7) \div \tfrac{1}{4} = \frac{.25 - .14}{.25} = .44, \text{ or } 44\%,$$

roughly. This makes the weight of coal per hour 1373 × .56 = 769 lbs., for power alone. To this must be added the amounts required for pumping the condensing water and for heating.

The next step is to compute the quantity of condensing water in order to determine the power required for pumping. Looking in Table I, the terminal pressure ratio for 1-7 cut-off and 9% clearance is .214, which would give a terminal pressure of (95 + 15) × .214 = 23.5 lbs., absolute and *H*, the total heat of the exhaust steam above 32 degrees, is 1154. For the heating season the average temperature of the injection water may be taken as 40°; the discharge water temperature may be taken as 110°. The formula for condensing water is

$$Q = \frac{H - (td - 32)}{td - te},$$

so that in this case the quantity required will be

$$Q = \frac{1154 - (110 - 32)}{110 - 40} = 15.37 \text{ lbs.}$$

The saving in fuel and water by running condensing was shown to be 44°, so that the weight of steam required by the engine when running condensing will be 12,360 × .56 = 6922, and if 20% of this is condensed in the cylinder it will leave 6922× .80 = 5538 lbs. to be liquefied by the condenser per hour. The quantity of cooling water required per pound of steam condensed being 15.37 lbs. there will be required 5538 × 15.37 = 85,119 lbs., or 85,119 ÷ 8.3 = 10,255 gallons of water per hour for cooling.

If 500 foot-pounds are necessary for pumping each gallon of water from the river, it will require 500 × 10,255 = 5,127,500 foot-pounds per hour, or 5,127,500 ÷ 60 = 85,458 foot-pounds per minute for this purpose; the power used therefore will be 85,458 ÷ 33,000 = 2.9 horse-power approximately. In the case of small direct-acting steam pumps, the weight of steam required is rarely less than 120 lbs. per horse-power per hour, so if this type of pump is used, the weight of steam will be 2.9 × 120 = 348 lbs. per hour, which will require 348 ÷ 9 = 38 lbs. of coal.

TABLE II.
Mean Pressure Ratios.

	Per Cent.	Clearance				
Cut-Off.	0	1.75	3	5	7	9
1-10	.330	.354	.360	.392	.413	.432
1-8	.384	.405	.418	.438	.457	.474
1-6	.465	.481	.492	.509	.524	.538
1-5	.522	.535	.545	.559	.572	.584
1-4	.597	.607	.615	.626	.636	.646
5-16	.676	.684	.689	.698	.706	.713
1-3	.699	.707	.713	.719	.727	.734
3-8	.742	.749	.753	.759	.765	.771
2-5	.766	.771	.775	.781	.786	.792
7-16	.799	.804	.807	.812	.819	.820
1-2	.846	.850	.852	.856	.858	.862
5-8	.919	.920	.921	.923	.925	.926
3-4	.966	.966	.966	.967	.968	.969
4-5	.978	.978	.979	.979	.980	.981
9-10	.995	.995	.995	.995	.995	.995

To find the mean pressure exerted throughout the stroke, multiply the absolute initial pressure (above a vacuum) by the number opposite the given cut-off and in the column corresponding to the percentage of clearance, and deduct the absolute back pressure.

It has been shown that 8000 lbs. of steam are required per hour for heating. This will require 8000 ÷ 9 = 888 lbs. of coal. Consequently, the total fuel required per hour when running condensing will be

Engine	769 lbs.
Pump	38 "
Heating	888 "
	1695 lbs.

as against 1373 when running non-condensing, during the heating season.

In order to make the comparison complete the coal consumption for a year must be computed. Suppose the factory runs 10 hours per day for 300 days. Then running non-condensing the weight of coal required for the year would be 1373 × 10 × 300 = 4,119,000 lbs. In the second case there would be required 1695 × 10 × 150 = 2,542,500 lbs. during the six months which require heat, and (769 + 38) × 10 × 150 = 1,210,500 lbs. for power alone during the other six months, making the yearly consumption, 3,753,000 lbs. This shows a margin of 4,119,000 — 3,753,00 = 366,000 lbs. in favor of the condensing plant. This would amount to 366,000 ÷ 2000 × 3 = $549 per year.

In the above comparison no account has been taken of the fact that the condensing water will be warmer in the summer, thus making the quantity of water and therefore the quantity of coal required for pumping somewhat greater in the summer than in the winter. This correction can be easily made if desired. An advantage of the non-condensing system not taken into account is the fact that the feed-water is heated up to a temperature of 210 degrees, while in the latter case the condensed steam in the hot well will range from about 115 to 125 degrees.

This example serves to show in a measure the method of making the computations for a number of the more important conditions which are commonly met with in practice. The data furnished in any special case will vary from that given above, but it is a simple matter to make the necessary substitutions. If one wishes to go into the smaller details more accurately it is an easy matter to do so.

In case one of the so-called vacuum systems is used, it effects the computations only so far as the back pressure on the engine is concerned. The amount of vacuum which it is possible to maintain in the heating system will depend almost entirely upon the tightness of the joints and freedom from leaks of various kinds.

From what has been said, it is evident that the greatest obstacle in the way of using a condenser to advantage is the cost, or the scarcity of condensing water. In order to do away with this extra expense and still retain the advantages to be derived from a condenser, various methods have been devised by means of which the discharge water may be cooled and used over and over again. The most common of these is the cooling tower, the various forms of which have been fully described in the AMERICAN ELECTRICIAN by other writers. With the best forms of cooling tower the temperature of the circulating water may easily be reduced by from 40 to 50 degrees with a loss not exceeding 3 or 4 per cent. of the total quantity of water passing through the tower.

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Association of Edison Illuminating Companies.—The twenty-third convention, which will be the eighteenth annual meeting of the Association of Edison Illuminating Companies, will open on Tuesday, September 9, at the Mt. Washington Hotel, White Mountains, N. H., Several very valuable papers are in course of preparation and all the present indications point to an unusually successful convention.

DEVELOPING A POWER SERVICE.

A number of opinions were presented before the Cincinnati Convention as to the best manner in which a central station power service may be developed. Mr. Ralph J. Patterson considered it to be a question of making the price right and letting people know it. He believed that the price should include an installation charge to make up for any loss due to the fact that the motor is only taking current part of the time. Mr. E. H. Mather, of Portland, Me., suggested an arrangement of the plant and distribution which will reduce the manufacturing and distribution cost to a minimum, and to present the advantages of electrical power to the public through capable solicitors.

Mr. Chas. H. Peters, of Durango, Colo., suggested selling motors on a small margin of profit, and in case where a customer using steam is thinking of making a change in power, to offer to take a few indicator cards under varying loads, from which to calculate the average horse-power, and then to give the customer an idea of what the power will cost him, approximately; otherwise a rate based merely on kilowatt-hours will not be understood.

Mr. John Gilchrist, of the Chicago Edison Company, advocated putting in the field as exclusive power solicitors men who have had some experience in the installation and running of machinery, who will present in detail to the users of power the advantages of electrical machinery. It should be made easy for a man to install the service, either by selling him the motors at cost, or enabling him to buy them upon a time basis of one or two years, with a very small interest charge. It should be assumed that no good business man is going to take up a new thing at a considerable expense unless the concern which is selling it is sufficiently anxious to get the business to do the walking and talking, and is willing to bear at least in part, if not all, the chances of its being unsatisfactory.

Mr. P. G. Gossler, of Montreal, said that preliminary to a contract, a customer should be induced to ascertain as nearly as possible what his power under present conditons is costing him. The customer should be favored who will have a high average demand; the rates for the customer who has a very variable load and a very high maximum, and low average demand, would necessarily be higher, but should still be below the cost of power supplied from an isolated plant. A reasonable reduction in rates should be made as the quantity increases, in order to encourage large power users to employ electric power. The basis of measurement should be the volt-ampere, and not the watt. There should be several bases for charging, and equivalent rates should be quoted in several ways, so that the customer may select the one which he thinks suits his particular case the best. A limited service field should be cultivated as much as possible by offering good discounts to customers who are willing to shut down their motors, in whole or in part, during the time of peak lighting load. In case of fixed and meter rates, the discount should be taken from the fixed rate, as this would be more attractive to the customer. Power users will be apt to be skeptical as to the feasibility of limited service, but if proper discounts are allowed, many will be found who can take power under this class of contract to the advantage of both customer and station.

An anonymous communication expressed the opinion that the best results will be obtained by employing a competent engineer to encourage power business, and to apply individual methods to each power consumer. The great difficulty in the way of obtaining power consumers, is that they always believe power is costing them less than it really is, and that they think they are using more power than they really are. The total power is best obtained by indicating the engine, and the transmission losses are measured by running certain groups of machinery idle some day when the factory is not in operation.

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POINTS CONCERNING INDUCTION MOTORS.

Several questions relative to the practical operation of induction motors were brought up by the "Question Box" at the Cincinnati Electric Light Convention. One of these was: "Is it possible to operate induction motors for elevator service and other intermittent use from lighting feeders without serious disturbance to electromotive force?"

In reply to this query, Mr. Ralph D. Mershon said that induction motors can be used for elevators and other intermittent service, and that if the proper type be installed they will cause practically no more disturbance on the lighting feeders than would be caused by the corresponding direct-current shunt motor for the same service. Mr. W. T. Oviatt said that his experience was that it is not possible to operate induction motors for intermittent service from lighting feeders without interference with the lighting. His experience includes single-phase motors up to 7½ horse-power, and three-phase machines up to 15 horse-power. The single-phase motors have been operated from a large system of secondary mains, with separate transformers; the three-phase have been operated only from separate transformers, and in all cases it has been found that they produce a serious disturbance to the lighting.

Mr. F. L. Sargent, of Malden, Mass., said that the motor business of his company is all three-phase and it does not allow any elevator service with induction motors, unless the motor is running continuously on tight and loose pulley or in the case of a hydraulic elevator, with a by-pass valve, as otherwise too much disturbance is caused in the e. m. f. at the generators. He added that all of the power-service circuits are independentt of lighting circuits. Mr. J. E. Barker's experience, at El Paso, Texas, with induction motors for elevators has been that the frequent starting and stopping causes the line e. m. f. to fluctuate to such an extent that it is impossible to do a satisfactory lighting business from the same line. This is not so important if a special power circuit is run, but as the starting current is often four times the full-load current, it is evident that large generators would be required to take care of a relatively small amount of business.

Mr. H. B. Geer, of the Chicago Edison Company, expressed the opinion that induction motors may be operated for elevator service and other intermittent uses from lighting feeders without serious disturbance of the pressure, under certain conditions. In Chicago this class of service is being carried on four-wire three-phase circuits operated at 2200 volts from neutral to phase wire, with 3800 volts between phase wires. The circuits carrying these motors carry the lighting load on one phase, the size of the wire on that phase and the neutral being designed to give 5 per cent drop from the station to the distributing center. The other two phase wires are No. 6 uniformly, the lighting wires being mostly No. 2. Such a circuit will carry elevators operated by 10 or 15-h. p. motors without serious disturbance in the pressure at a distance of two or three miles from the station or sub-station.

Mr. J. H. Perkins, of Youngstown, O., considered that under certain relative conditions between generator and motors, and if the motor is supplied by an independent transformer or a bank of transformers whose capacity is largely relative to the motor, it is possible to operate satisfactorily induction motors on elevator loads. Mr. Charles F. Scott said the answer to the question depends on conditions. In some stations where the conditions are favorable, various classes of motors can be operated without interference to the lighting service. In other cases it is not true. The same statement might be made with regard to direct-current motors. The question might be put: Is it possible to operate direct-current motors for elevator service and lighting on the same service? Mr. Scott said he knew of cases where the induction motor has been criticized for not doing good work on elevators where a direct-current motor would not be used, and in such cases the induction motor is expected to do more than the direct-current motor would do.

Another question considered was as follows: "What specification should prevail in purchasing induction motors to insure least disturbance to line electromotive force?"

In reply Mr. Ralph D. Mershon said that the type of motor should be that having a rheostat included in its secondary circuit, the rheostat being such that it may be cut out by as great a number of steps as is necessary to keep the disturbance down to the point desired. In specifying the number of steps there shall be in the rheostat and the magnitude of each step, one should follow the course which would be followed in specifying the starting rheostat for a direct-current shunt motor for the same service as that which the induction motor has to meet. In addition, the motor should, of course, have as high a power factor at all loads, as is consistent with the maximum torque that will be required of it.

Mr. Charles F. Scott stated that specifications are sometimes presented which place the starting current as a certain fraction of the full-load current, independent of the size of the motor. That is evidently not a fair thing, as a circuit which will enable a 10-h. p. motor to start with, say, its normal full load conditions—that is, taking its normal full-load current at the start—would permit of a 1-h.p. or 2-h.p. motor being started with two, three or four times its full-load current, and not make the same disturbance on the circuit that the 10-h.p. motor would starting with only its normal current. It would be better, therefore, in specifications of this kind, to place some limit upon the amount of current which can be taken from the circuit, or make different specifications for different sizes of motors, instead of making a specification which refers alike to all motors. If the starting current is specified in terms of a full-load current, then it may be that a poor motor would pass the sepcifications, and a good motor would not. For example, suppose two motors were used which took the same starting current, but one of them took a considerably greater running current than the other; the one with the greater running current would then be the poorer motor, but as it takes less starting current it might pass the specifications where the other motor would not.

A question that elicited a large number of replies, was as follows: "What has been the experience from the use of single-phase induction motors above one horse-power on lighting feeders?"

Mr. Ralph J. Patterson, of Waterville, Me., said that his company has in use one 40-h.p., one 15-h.p. and one 25-h.p. induction motors on its lighting-service lines, with no bad results, although it is true that there is a variation of the voltage in starting and stopping them. Mr. F. L. Sargent, of Malden, Mass., said that before the power circuits of his company were completed, several single-phase motors were on his light, ing feeders. from 1½ to 5-h.p., and they caused no trouble.

Mr. W. J. Greene, of Cedar Rapids, Iowa, said that a 15-h.p. single-phase induction motor caused no disturbance in regulation; at least no complaints were received that could be attributed to it. The motor was in use for five months prior to December 24, 1901, for operating a stone-crusher. Mr. C. E. Barrows, of Walla Walla, Wash., said his company has a 15-h.p. Wagner single-phase induction motor running a pump, current being generated at a water-power station five miles away. Every time the motor is started or stopped every incandescent light in town is affected; it is a great nuisance. Mr. H. T. Gille, of St. Paul, Minn., said that the largest induction motor on the St. Croix lighting feeders is 3 horse-power. No trouble has been experienced from motors up to this size interfering with the regulation on the lighting system.

Mr. J. H. Perkins, of Youngstown, O., said single-phase motors up to sizes of 20 horse-power had been satisfactory in every way and they will do all that can be done with a polyphase motor. They have an advantage in requiring only two wires and one transformer, which makes the cost of installation less and makes it economical to reach out-of-the-way places as well as the point near the center of distribution. Motors that have been in service some three years have never had repairs or caused trouble. Mr. Perkins added that he would rather have ten alternating-current motors on his line than one direct-current machine. His company operates 500-volt direct-current and both single-phase and polyphase motors.

The Missouri Edison Electric Company reported that the entire alternating-current distribution of the company is single-phase In the concentrated business district it has the transformer secondaries cribbed on a three-wire system, this network being fed from large transformers, the primary circuits of which are independently controlled from the station distribution switchboard. This network is of ample capacity for almost any demand that may be made upon it, and throughout this district it has been the practice to place no limit upon the sizes of single-phase alternating-current motors installed. There are several hundred single-phase motors operating with entire success on this underground network, a number of which installations have individual units of as high as 35 horse-power, with individual customers taking as high as 75 to 100 horse-power for motor service alone. Practically all of these motors are of the Wagner type, wound for 208 volts. In starting they are thrown on 104 volts, on which pressure they run up to about two-thirds speed, and are then thrown over to the 208-volt feeders. No difficulty has been experienced in operating incandescent lamps on the same service feeders, and the use of single-phase motors in preference to other methods has enabled the company to very greatly simplify its general distribution system.

In the outlying districts of St. Louis the alternating-current feeders are of 100 kilowatts capacity each. On these circuits the installation of single-phase motors is permitted under the company's superivision, up to 10 and 15 horse-power. In one Particular instance a 15-h.p. motor is operating satisfactorily at a distance of four miles from the station. It is the practice to require all these motors to be wound for 208 volts, and it is exacted that they start on 104 volts in exactly the same way as in the downtown disricts. Where the motors are located at remote distances from the station, it is also recommended that they be started without load. By careful supervision of these outlying installations, the company has been able to take on a great deal of alternating-current motor service without detriment to its lighting distribution, and in its opinion, the single-phase motor of to-day is a thoroughly practical and satisfactory machine; and if installed with intelligent supervision, it affords a means of securing a very satisfactory alternating-current day load from districts into which it would be expensive and inconvenient to carry either a polyphase alternating or a direct-current system of distribution.

The Quincy Gas & Electric Company reported that it has a number of these motors installed. By putting in sufficient transformer capacity, as recommended by the companies furnishing the motors, no difficulty or inconvenience is found in running them on lighting feeders, and their use beyond the regular power circuit is quite a help to the incomē account. Mr. H. B. Gear, of the Chicago Edison Company, said that single-phase motors of 1 to 5 horse-power are being operated for general power work in large numbers in Chicago from lighting feeders. Such motors when started will often produce a dip of about 5 per cent in the primary pressure; but as they are started usually not more than two or three times a day and at times when very little lighting is in use, there has been no difficulty with customers' complaints on account of these motors being on the same circuit. Motors of 1 horse-power or larger are carried on separate transformers. In a few instances installations of several 2-h.p. motors aggregate 10 to 12 horse-power. These motors have been found to affect the shape of the day-load curve very noticeably.

The Whitehall (Ill.) Electric Company reported that in the last three years it has installed seven of this type of motors and is very well satisfied with the results. It has two of 25 horse-power, three of 10 horse-power, and two of 2 horse-power. The two 25-h.p. motors have particularly hard service; one is used to pump water from the city reservoir to a tank, being run after midnight, without attendance, and lifting 15,000 gallons 150 feet high through 6000 feet of six-inch pipe. The other is used to run a clay-grinder in a pottery, and has to contend with a variation of from no load to 30 horse-power every half hour, and also a change of 6 horse-power in the load five times every two minutes. These motors are all run from a 60-kw. dynamo, and with one exception, are on all the lighting feeders. The company has never had any trouble with the motors, and no complaints from its customers regarding the light furnished. The motors are in first-class condition and there is no reason why they will not continue to give good service for years.

In reply to questions, Mr. A. B. Behrend said that any polyphase motor gives its output with less material than the single-phase motor. One may consider a single-phase motor as equivalent to a three-phase motor one phase of which is cut out or interrupted. As to cost, there is a difference between cost and price. One has to compare shop cost and selling price on two entirely different bases. A builder may have to sell a three-phase motor for about two-thirds of what he would have to sell a single-phase motor for. It is perfectly natural that a single-phase motor should cost more than a two-phase motor, because it contains more material.

Mr. Frank H. Taylor, of Pittsburg, said that the experience of central station people with alternating-current motors is about the experience that he used to find as a salesman for the Yale locks. There was no apparent reason why Yale locks should cost more than Corbin locks or the locks of any other good manufacturer; but anyone who bought a Yale lock was never sorry he bought it and paid the price which it cost. The same thing is true of induction motors. The price is not excessive and anyone who buys one motor will buy more.

In reply to a query, "What system of charging best lends itself to the supply of power with induction motors?" Mr. W. J. Greene, of Cedar Rapids, Iowa, favored a two-rate sysem, in which allowance is made for the cost of increased investment in generator, transformer and wire capacity, due to the effect of the low power factor. Another opinion expressed was that a consumer should be charged for "readiness to serve," on a basis of maximum demand of motor. The maximum demand should, in this case, be considered the demand which would blow a fuse of rated capacity, as distinguished from instantaneous demand.

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POLYPHASE INDUCTION MOTORS OPERATING ON SINGLE PHASE CIRCUITS.

BY A. S. M'ALLISTER.

A two-phase induction motor may be brought up to speed on a single-phase circuit by connecting the windings of both phases to the circuit, one directly and the other through a suitably chosen resistance or condensance, as shown in Fig. 1. The current through the circuit containing the resistance will alternate more nearly in unison with the impressed e. m. f. than that in the other, and it will possess a component in quadrature to the current in the other circuit, which component will produce the desired quadrature flux. The elliptical revolving field thus produced will give a torque which will start the motor up from rest, if the load be not too great. When about half speed has been attained the circuit through the resistance is cut out and the motor operates as a single-phase machine.

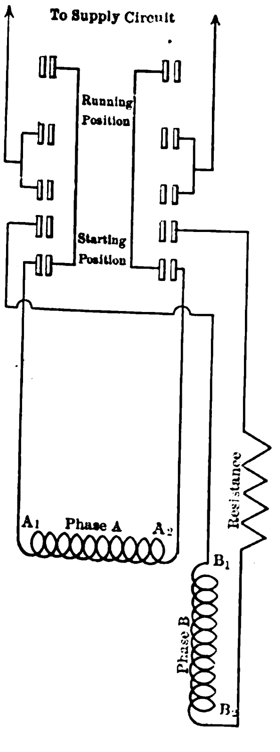


FIG. I.

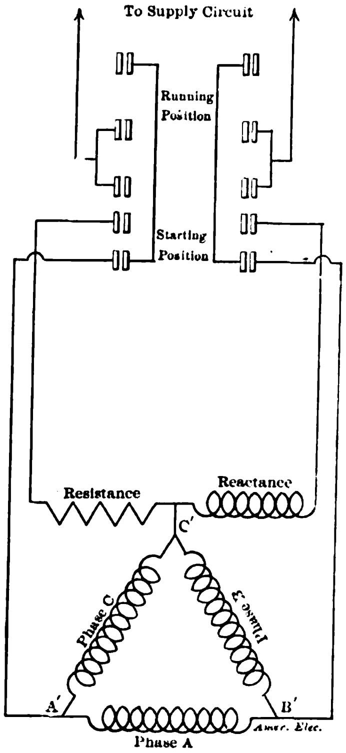


FIG. 2.

Under the conditions of operations, it will be found that there is generated in the inactive phase winding an e. m. f. equal (for negligible secondary impedance) to the counter e. m. f. of mechanical motion in the active phase winding, and that this e. m. f. is almost in quadrature in time-position with the supply circuit. The lack of exact quadrature is due to the lag of the counter e. m. f. of rotation in the active coil behind the impressed e. m. f. and to some extent to the further lag of the secondary exciting current behind this e. m. f., and the sign of the angle of displacement from 90° depends upon the direction of rotation of the motor secondary. Fig. 3 shows the relative value and position of this tertiary e. m. f. for a two-phase motor running single-phase, while Fig. 4 indicates equivalent results for a three-phase motor, on a single-phase circuit.

By combining the e. m. f. of the inactive winding of a two-phase motor with that of the supply circuit, there is available an almost symmetrical two-phase circuit, from which may be started at once, without auxiliary apparatus, any similar two-phase, or, by a few slight changes, any three-phase induction motor. The draught of current from the inactive phase winding will have very little effect upon the operation of the first motor. By this method it is possible to dispense with auxiliary starting apparatus for all motors of any given installation, with the exception of one, and, with properly arranged circuits, two-phase motors may in this manner be started up with a fair operating torque.

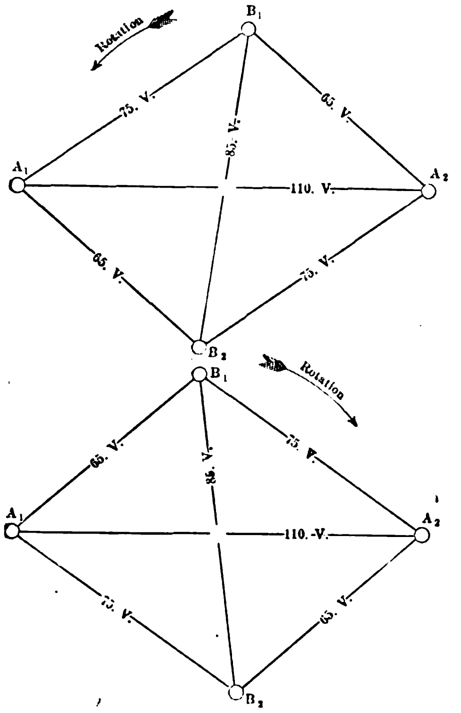


FIG. 3.

A three-phase induction motor may be operated from a single-phase circuit by connecting two leads from the motor directly to the supply circuit and joining the third to an auxiliary starting circuit, formed by placing a resistance and a reactance in series across the supply circuit, as indicated by Fig. 2.

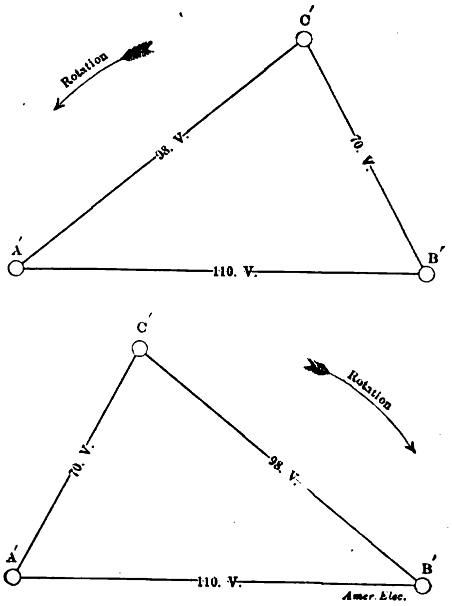


FIG. 4.

The effect of placing the resistance and reactance in series is to displace the relative potential of the point where the two join, from a line connecting the extremities of the two, as shown in Fig 5. For a true reactance the locus of this point, with varying resistance, is the arc of a circle, as indicated by Fig. 6, and the maximum displacement occurs when the resistance and reactance are equal. Under this condition the displacement (when no current is being taken off at P) will be $S\ E_T$, or one-half the line voltage, S being the speed in per cent of synchronism. For a true three-phase circuit, the displacement should be

$$\frac{\sqrt{3}}{2} E_T = .866\ E_T.$$

It is clear, therefore, that this method cannot possibly give e. m. fs. in true three-

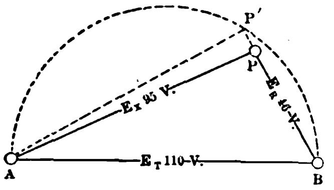


FIG. 5.

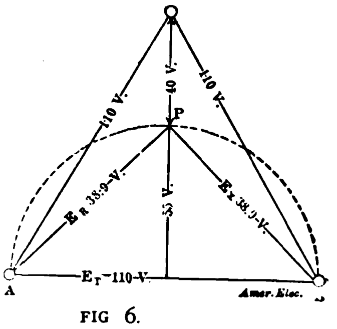


FIG 6.

phase relation. It is found, however, that the displacement obtained is adequate for starting motors of moderate sizes.

The use of condensance, instead of inductance, offers some advantages, since by properly proportioning the condensance, the leading current demanded may be adjusted to equality with the lagging exciting current during operation and, theoretically, a power factor of unity may be obtained. The disturbing influence of change of frequency, the compensating disadvantages due to presence of higher harmonics from the distortion of the e. m. f. wave from a true sine curve of time-value, and the practical necessity of operating condensers at high voltage, coupled with the lack of satisfactory commercial condensers in convenient form, have hitherto limited the application of this method, but present practice seems to indicate a more general adoption of condensers for this purpose hereafter.

The instantaneous value of torque is proportional to the product of field strength and amature current. If the armature current and field magnetism reverse together, the torque will always be exerted in one direction. For this reason a direct-current series motor when subjected to an alternating current will develop a torque sensibly in one direction, and the armature will therefore tend to speed up as though operating on a direct-current circuit. Practical difficulties due to vicious sparking at the commutator and to the necessity of well-laminated field cores and highly insulated field coils have limited the application of this method to a few special cases. It has been applied with some degree of success for bringing to approximate full speed certain types of small-size single-phase synchronous motors. For induction motors, in which simplicity is the criterion of worth, this method is especially objectionable on account of the complications introduced by the necessary auxiliary starting circuits.

An Interesting Residential Electric Light and Power Plant

An extremely interesting residential plant, in point of size, as well as of serviceability, is situated at the country place of Mr. R. P. Linderman, at Fisher's Island, N. Y. It is seldom that a private residential plant assumes such proportions as to necessitate being separately housed, and attended by two or three persons; nor are embellishments usually bestowed on residential equipments such as are found in the plant under discussion. The high finish given to all of the machines and their appurtenances would at first glance indicate a plant for exhibition rather than for general utility; but the character of the work performed by this miniature central station shows that such a supposition is untenable.

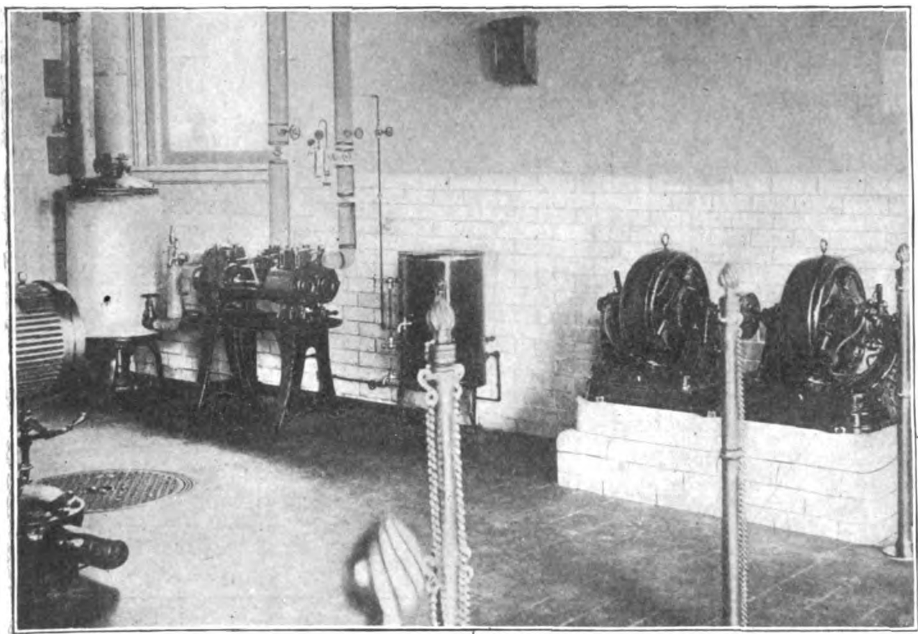


FIG. 1.—CORNER OF ENGINE ROOM.

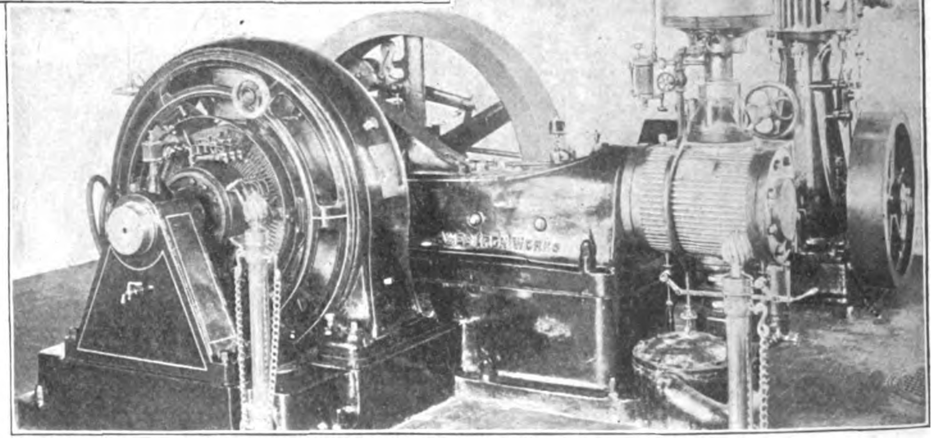


FIG. 2.—GENERATING UNITS IN RESIDENTIAL PLANT AT FISHER'S ISLAND.

Mr. Linderman's country home covers a considerable area of Fisher's Island overlooking the Atlantic Ocean, and comprises two very large residences, known as the "old" and the "new" house, a bath house, boat house, paddock, pump house, power house and conservatories. The houses are widely separated, the power house being about one-quarter of a mile from the residences and up toward the center of the island; a pump house is located about 100 yards from the power house. All of the other houses are situated near the residences, the boat and bath houses, of course, being at the water's edge. The buildings and roads are lighted throughout by electricity, and private water and fire systems are also maintained.

Steam is generated by a horizontal return tubular boiler, made by the Ames Iron Works, of Oswego, N. Y., set in brick and cement mortar with selected pressed brick on the exposed sides. The bridge walls, furnace linings and all other parts exposed to the hot gases are lined with fire brick laid in fire clay, with headers put in every six courses to facilitate repairs. The ash pits and back connections are paved with brick grouted in cement. The top of the boiler is bricked in and an air space left between the shell and the brickwork. A 28-inch circular flue, made of No. 10 iron, riveted and braced, connects the boiler with the chimney. The damper is controlled by a regulator, made by T. P. Ford, of Brooklyn, N. Y.

The boiler may be fed by either a duplex steam pump or an injector, the latter serving as a reserve; the steam pump ordinarily furnishes the feed water. The pump is set in a cast-iron pan, as shown by Fig. 1. It is furnished with brass fittings and arranged to pump hot water. The steam end is covered and lagged with Russia iron with brass trimmings, and the balance of the pump and supporting stand is painted and striped to match the engines. The suction of the pump is connected to the well pipe in the tank room, which pipe also serves the injector and hose lines. The pump is by-passed, so that the boilers can be filled from the house tank. The pump suction is also connected to the drip tank, so that the latter may be pumped out when desired. The discharge is connected to the boiler through the heater and also to the sewer; an outlet is provided in the feed-water piping above the heater for hot water. The feed passes through a small American feed-water heater having water coils of seamless drawn brass tubes. The coils and feed pipes are arranged with a by-pass and valves so that the coils can be disconnected and removed without shutting down the feed line. All water pipe is heavily galvanized, with the exception of the feed pipe between the heater and the boiler, which is of heavy brass.

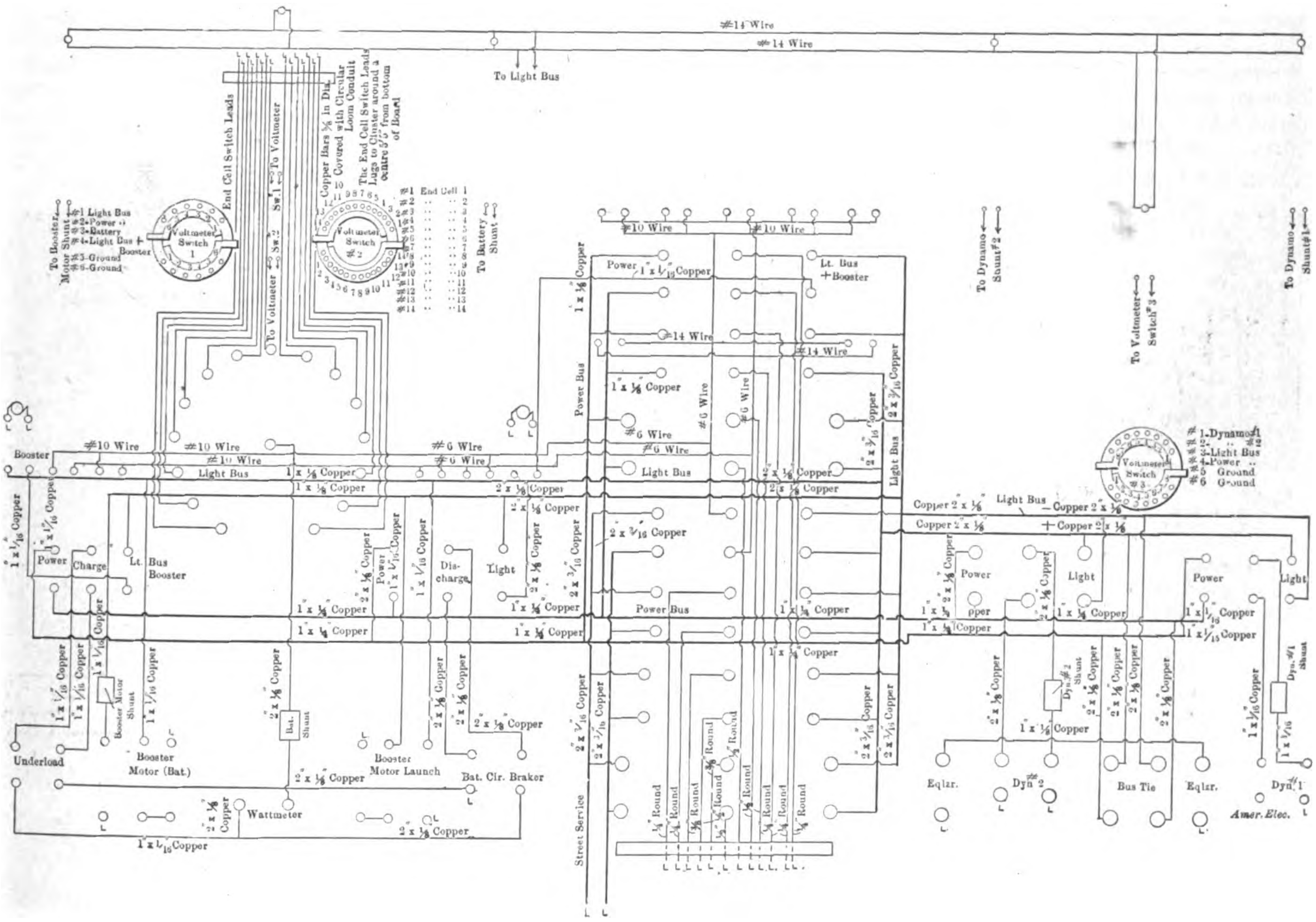
The generating units in the engine room are a 25-kw. 125-volt G. E. dynamo, direct-connected to a simple horizontal engine built by the Ames Iron Works, Oswego, N. Y., and running at 300 r. p. m. and a 10-kw. 125-volt Eddy generator, direct-connected to a simple vertical engine, built by the New York Safety Steam Power Company, and running at 400 r. p. m. The room also contains two "Wood" motor-driven multiple boosters, one having a capacity ranging from zero to 120 amperes at all voltages from zero to 50 volts for charging storage batteries, and the other having a capacity from zero to 40 amperes for charging the batteries of an electric launch. Both boosters were made by the Fort Wayne Electric Works, Fort Wayne, Ind.

Steam is fed from the boiler to the engine by a 3½-inch pipe equipped at the throttles of the engines with direct steam separators. The piping is constructed for a working pressure of 100 pounds per square inch, and is provided with sufficient flanged unions to allow any section of pipe to be readily removed, the couplings and fittings being of malleable iron. All valves over three inches are extra heavy iron-body gate valves with bronze seats, while those under three inches are extra heavy globe valves of brass. The pipes are so placed that the condensation gravitates in the direction of the flow of steam.

The exhaust is discharged through the heater by a 4-inch pipe. All valves on the exhaust are of the iron-body Chapman gate type with steam babbitt seats. The same provisions to assist drainage are made as in the case of the steam piping. The exhaust from the small engine connects with the main exhaust over the heater. The main steam pipe is drained toward the separator and the latter is drained by a small pipe running down the side of the steam chest to the exhaust and drip trench, which runs under the floor to the trap discharging into the drain pipe. The engine cylinders are provided with a valve and check on each end, and the two ends are brought together and run down through the exhaust and drip trench into the drain pipe. The small engine, pump and heater also drip, with proper checks, into the drain pipe. Steam and drip connections are provided for the oil filter shown by Fig. 1. Valves are placed on the pipes wherever there is a liability of difference in pressure likely to carry water in a direction opposite to that intended, and individual stop valves are placed in the pipes leading into the drain, so that they can be closed during blow-off. Heat is supplied to the plant by a 1-inch pipe, which feeds radiators in different parts of the building.

The boiler is provided with a blow-off pipe to the drain. This pipe runs underground to a point where it can discharge into the sewer pipe without affecting the drips. A relief valve is provided on the steam-pump discharge line. All of the high-pressure steam piping, drip piping and traps, and all feed-water piping on the pump to the boiler, is covered with 1¼-inch magnesia and finished with heavy duck, neatly fitted and sewed on. All of the exhaust piping, drips and traps, low-pressure pipes and traps, water pipes, blow-off pipes and steam-heating pipes are similarly covered with 1-inch Keasbey's magnesia. All of the valves and fittings in the exhaust by-passes and heating pipes are covered with 1-inch sectional covering. The feed-water heater is covered with 1⅜-inch magnesia block and plaster, and the pipe trenches are carefully packed with mineral wool. All of the steam-pipe covering, etc., is tinted to harmonize with the furnishings and fittings; and the apparatus in the engine and tank rooms, after being rubbed down, is painted with coach black and striped in gold.

The switchboard is made of white marble and was installed by the Walker Electric Company, of Philadelphia, Pa. The marble is 1½ inches thick, supported on an angle-iron frame resting on pedestals braced with angle-iron firmly embedded and insulated in the wall. Above and at the ends the board is enclosed in electro-bronze



#14 Wire
To Light Bus
End Cell Switch Leads
To Voltmeter
Copper Bars ⅜ in Dia. Covered with Circular Loom Conduit
The End Cell Switch Leads Lugs to Cluster around a centre 5" from bottom of Board
Voltmeter Switch 1
Voltmeter Switch #2
End Cell 1
To Battery Shunt
To Booster Motor Shunt
#1 Light Bus
#2 Power
#3 Battery
#4 Light Bus + Booster
#5 Ground
#6 Ground
#10 Wire
Power 1 x 1/16 Copper
Lt. Bus + Booster
#14 Wire
1 x ⅛ Copper
#6 Wire
Light Bus
Power Bus
Booster
Power
Charge
Lt. Bus Booster
Dis-charge
Light
2 x 1/16 Copper
Booster Motor (Bat.)
Booster Motor Launch
Bat. Cir. Braker
Underload
Wattmeter
Street Service
½ Round
To Dynamo Shunt #2
To Dynamo Shunt #1
To Voltmeter Switch #3
Voltmeter Switch 3
1-Dynamo
2
3-Light Bus
4-Power
5 Ground
6 Ground
Copper 2 x ⅛
Eqlzr.
Dyn. 2
Bus Tie
Dyn. 1
Amer. Elec.

FIG. 3.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

screenwork, having a door at one end. The front of the board is surrounded by a plain polished copper molding three inches wide, which at the ends covers the angle-iron and makes a neat joint with the grill work and door. All of the circuits and switches are marked with engraved copper plates with filled black enamel letters. The heavy bus-bars are laminated and the studs are all of forged copper. The connections for the ammeters and voltmeters, and all small wires, are run in flexible tubes fastened to the marble by brass clasps. All circuits not provided with circuit-breakers have fuse blocks on the switches. The space behind the board is lighted by two incandescent lamps held in polished brass receptacles on the wall and controlled by a switch on the board. Fig. 3 is a diagram of the switchboard connections.

The board contains two rheostats; two Weston ammeters and shunts; one 125-volt illuminated-dial Weston voltmeter with a circular switch marked with an engraved plate, to connect it to both dynamos, all bus-bars and the battery leads, and also to act as a ground detector; two double-pole automatic magneto circuit breakers; two single-pole equalizing switches; two double-pole double-throw knife switches for dynamos; one 200-ampere single-throw knife switch to connect busses; seven small double-pole knife switches with fuses connected to lights in the power house; one 200-ampere double-pole double-throw switch for house and paddock; one 50-ampere double-pole double-throw knife switch for charging launch on booster or power busses; one 50-ampere double-pole double-throw knife switch for the boat and bath houses; one 100-ampere double-pole double-throw knife switch to the new house; one 50-ampere double-pole double-throw knife switch to the house pump; one 200-ampere double-pole double-throw knife switch to the fire pump, and one 50-ampere double-pole double-throw knife switch for the station lights and lights on the roads.

The storage-battery section has one round-pattern Weston voltmeter reading from zero to 100 volts, and one circular switch marked with engraved plate, connected to the charging and discharging circuits and both busses; one round-pattern Weston shunted ammeter; one round-pattern Weston shunted ammeter reading to 100 amperes for the launch-booster line; one portable Weston voltmeter, with circular switch marked with engraved plate, to connect same to end-cell switch connections to the battery; one General Electric double-acting wattmeter; one circular end-cell switch; one automatic underload switch; two rheostats to booster; two starting boxes for boosters; two double-pole automatic circuit breakers of 300 amperes and 125 amperes capacity, respectively; two double-pole double-throw knife switches; two double-pole single-throw switches and fuses for booster motors; four double-pole knife switches with fuses connected with lights on the board, and two double-pole single-throw switches to booster fields.

The general scheme of lighting is as follows: There are two sets of lighting bus-bars—one for the plant service and one for pump service, and the switches are so arranged that any lighting feeder can be connected to either set of bus-bars. There are also two dynamo bus-bars, one for light and one for power, with a switch to throw them together. The pumps and the battery are connected so that they can be thrown on either pair of bus-bars, the battery board connecting from the dynamo bus-bars by means of copper bars. The wattmeter is connected so as to show both charge and discharge. The cell switch is connected to the cells by means of lead-covered copper rods. The feeders run to the edges of the board in the form of copper rods covered with flexible conduit.

The storage battery, consisting of 65 cells, was installed by the Electric Storage Battery Company. It is situated in a room off the engine room and has the following capacities: When discharging at the rate of 60 amperes it has an output of 400 ampere-hours; when discharging at the rate of 120 amperes it has an output of 360 ampere-hours, and when discharging at the rate of 240 amperes it has an output of 240 ampere-hours. With these rates of discharge the voltage of no cell is permitted to fall below 1.7, the voltage being measured while the rated load is being discharged. Each cell is set on insulators and thoroughly insulated from ground leakage.

The automatic piping system for supplying fresh water for domestic purposes and salt water for the fire system is controlled from two separate points. In the room adjoining the engine room are the tanks for the fresh and salt water. These are made of steel and have manholes near the top and gauge glasses with stout rod-guards connected to the tanks. The tank for the house service is four feet in diameter and seven feet long, and that for the fire service is four feet in diameter and ten feet long. The tanks are placed one over the other, the fire tank resting on cast-iron cradles set on brick piers. The house tank is hung from double sets of channel irons by wrought-iron bands, the channels resting in the side walls of the room on cast-iron plates.

The house pump equipment is situated in a pit in the tank room and consists of a General Electric motor, direct-connected to a Quimby screw pump. The motor is controlled by an automatic regulator, made by The Electrite Company, of New York. The water is pumped from a 34-foot well into a suction tank and thence into the house tank, where it is kept under a pressure of forty pounds. Each pump is provided with a by-pass between the suction and the discharge, with a valve and a reducing valve to prime the suction, and also to allow leak enough to automatically start and stop the pump once in every twenty-four hours. A foot valve and strainer are provided on the house-pump suction.

The salt water tank is supplied from the pump house situated near the water's edge.

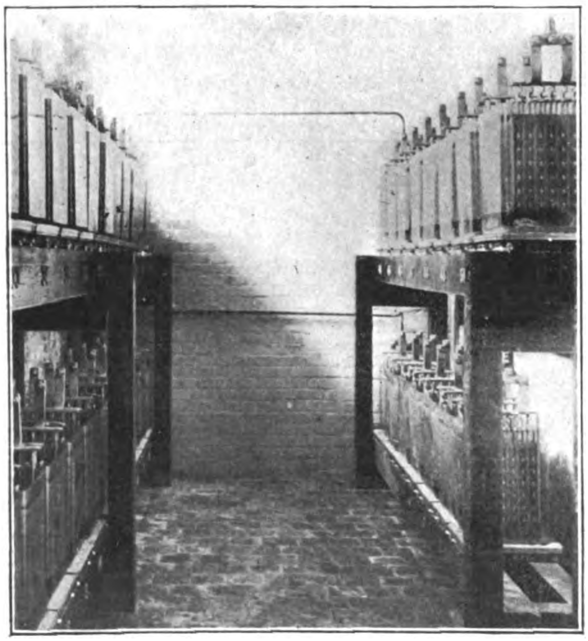


FIG. 4.—STORAGE BATTERY.

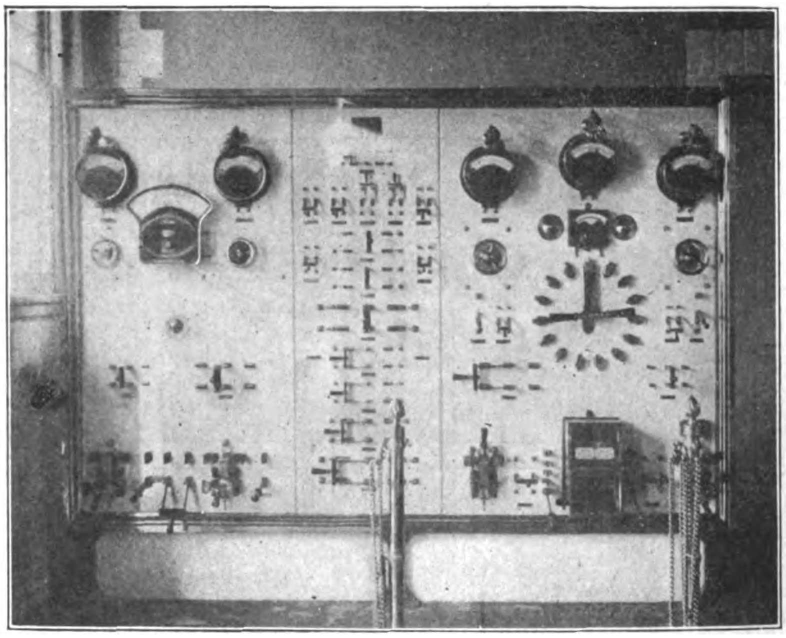


FIG. 5.—SWITCHBOARD.

A Quimby screw pump is direct-connected to a 15-h.p. General Electric direct-current motor, and is controlled by a Sundh pressure regulator and an automatic motor starter, made by Otis Brothers, New York. The pressure in the tank is maintained at ninety pounds, and should the pressure fall below this the pump is automatically stopped.

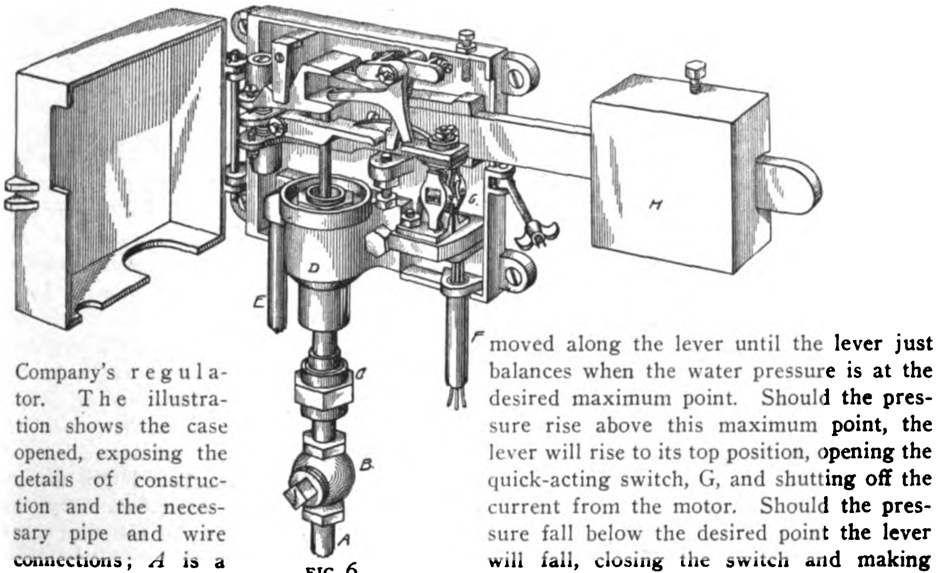


FIG. 6.

Fig. 6, herewith, shows the Electrite Company's regulator. The illustration shows the case opened, exposing the details of construction and the necessary pipe and wire connections; *A* is a ¾-inch pipe connecting the regulator with the pressure tank, into which the pump is discharging, and *D* is a cylinder containing a packed plunger. Water pressure is communicated to the bottom of this plunger through the pipe, *A*, and the upper end of the plunger bears upon the under side of a lever carrying the weight, *H*. The weight can be adjusted so as to counterbalance the upward pressure of the plunger at any desired pressure in the tank system. A quick-acting switch, *G*, opens when the weighted lever reaches the upper end of its movement, and closes when the lever reaches the lower end of its movement. *F* is the pipe conduit carrying the electric wires from the motor starter to the quick-acting switch, *G*. A drip pipe, *E*, carries off any leakage which may occur around the packed plunger.

In operation, when the connections have been made as shown, the weight, *H*, can be moved along the lever until the lever just balances when the water pressure is at the desired maximum point. Should the pressure rise above this maximum point, the lever will rise to its top position, opening the quick-acting switch, G, and shutting off the current from the motor. Should the pressure fall below the desired point the lever will fall, closing the switch and making connection between the circuit and pump motor, thus starting the pump. An electric heater is provided in the pump house for use in cold weather.

To the south of the boiler room is a storage and charging room for an electric automobile. The room is equipped with a rheostat and charging plug and a Sprague motor driving a triple-cylinder Claason-Peters air pump for inflating the tires of the automobile.

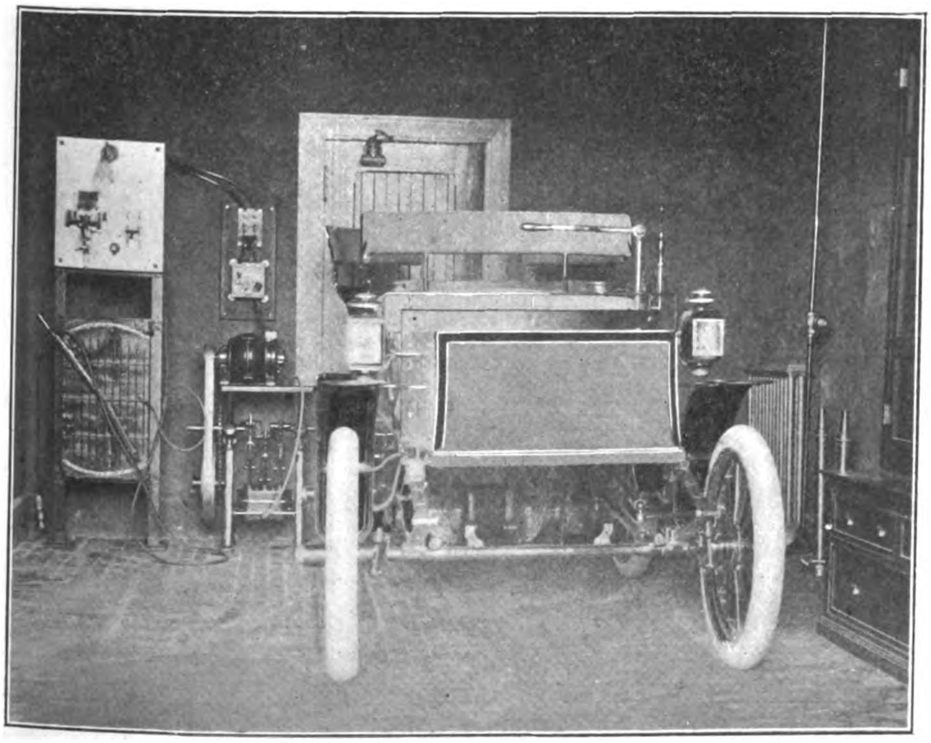


FIG 7.—AUTOMOBILE STORAGE AND CHARGING ROOM.

All of the transmission wiring is run underground in conduits, with manholes situated at convenient places. The manholes are of brick and covered with checkered iron covers set in an iron curb. A telephone system is also maintained, connecting all of the various buildings. The plant was installed under the supervision of Pattison Brothers, consulting electrical engineers, of New York City.

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TELEPHONE ENGINEERING.

BY F. J. DOMMERQUE.

LAYING OUT THE WIRE PLANT.

As previously stated, in laying out the wire plant of an exchange all subscribers are plotted upon the map. To begin with it is assumed that the exchange is of such a size only that each subscriber can be marked down. What to do with larger exchanges will be shown later. Then the office is located (assuming that there is only one; if there are more than one, proceed with each one as here illustrated for one office only), and the two or four main routes for the pole lines and conduits determined. Beginning at the outskirts of the exchange, the subscribers should be collected into open wire pole lines first, then into aerial cables, and finally into underground cables.

In an earlier article it was stated that it is necessary to enter upon the map not only the present number of subscribers but also the subscribers that were to be expected in the future. The reason for also requiring the future subscribers is to lay out the underground conduits, as these must be built right at the beginning so as to afford sufficient duct space forever. As far as the pole lines are concerned, poles should be large enough to carry at least three cross-arms, and strong enough to carry ultimately as many cables as the future number of subscribers may require; for the present time, however, the poles are to be equipped with facilities for the present number of subscribers only.

Each main run is taken at the time and followed up by simultaneously collecting the subscribers abutting on this run and adding the feeding lines as they merge into the main run. It must be learned from inspection whether the street or alley selected for a pole line or conduit is available or whether a better or more economical route may be found. Of course each pole line must be anchored to an anchor-pole or similar device to counteract the pull of the wires in the opposite direction. At every corner, bend or curve in the line one or more guy poles are required to equalize the stresses on the corner-pole or on the poles in the curve. Whenever sufficient subscribers are collected to start an aerial cable, a cable pole must be inserted, until finally the underground conduit is reached, where another cable pole forms the connecting link between the aerial and underground construction. As the underground conduit proceeds towards the office, laterals may be taken in or distributing poles planted; manholes must be constructed, etc., all of which must be determined in succession.

On a map to a large scale each pole from the far end of the pole line onward is marked down, observing the rules which will be given in detail later on in the discussion of pole lines. Simultaneously with marking of the poles a list of reference should be made, which may be headed "Pole line on the north (or south or east or west) side of ....Street," or "in alley north (or south or east or west) of ...... Street," a list to be used for each street or for each main run, according to the length of the line. On this list the starting point of the line as well as the terminal point is entered, as follows: "From the intersection of .... Street and .... Street to the intersection of .... Street and .... Street," or "from house number .... to house number ...." as the case may be. Also the length of the run covered on this list should be given, either in feet or in miles, usually in feet, as each run will hardly ever cover a mile, except on long country lines, which do not concern us now. Then each pole is noted, giving its height (as a rule the height of a pole means its length over all, and not merely its elevation above the ground), the number of cross-arms, the number of open wires on the pole, the material and gauge of wire, the number of aerial cables, if such are upon the pole, the number of pairs in the cable and their gauge; then the next pole is taken and the distance from this pole to the last one entered; the same details are recorded for each pole in the line. Also the number of anchor-poles or anchor-rods, of guy-poles, distributing poles and cable-poles and their equipments are entered, so that ultimately the list gives the complete history of the line. It should not be omitted to give each list a page number and a date; also remarks should be made of any particularities in the way of the lines, such as railroad crossings, transpositions, etc.

In alleys, sometimes so-called alley-arms are used, such arms extending only on one side of the pole; record should be made of such arms. If the cross-arms employed by the telephone company are all of one size, no particular description of them need be given with each pole. If, however, the arms vary in size, the dimensions of the arms should be given each time. Many telephone companies have printed lists upon which all the above information is to be entered.

In laying out the wire plant no detailed account is made of the house connections, *i. e.*, of the tap or service wires from the pole nearest to the subscriber's premises to the telephone instrument. In estimating upon the cost of the wire plant an average figure is taken for house connection, as there is necessarily a great variation in the amount of wire required and in the labor involved in entering the house. Where the construction is mixed, that is, where the main run is underground and the feeding lines aerial, or where all wires but the house connections are underground, a list may be made of the aerial part, and another one of the underground part. It is advisable to keep underground data separate from the aerial.

The list for the underground conduits may be arranged similar to the pole line list; giving the side of the street the conduit is to be on, also the points of starting and ending, and the length of the conduit. When giving the length of the conduit, the latter should be measured from man-hole wall to man-hole wall, *i. e.*, the length of the man-hole should be subtracted, if very accurate measurements are wished. For making estimates, however, and for laying out the wire plant, this is seldom done. Then the number of ducts in the conduit is recorded, and, in case various types of ducts are used, a description of the duct material is inserted, as for instance "single-duct tile," or "four-duct tile," or "cement-lined pipe," etc. Next may be inserted the number of underground cables, giving also information as to number of conductor pairs in the cables, their gauge and other electrical data, such as capacity, insulation, resistance, etc.

Another item on the list is the number of man-holes; their general dimensions, inside length, width and height will be all that would here be necessary; then the number and feet of laterals and their location if such are used. If distributing poles are used, they should be entered upon the pole line list.

These lists may serve as a preliminary to construction work, or also, and this is mostly the case, as a guide in estimating upon the cost of the wire plant. The following may show how the data could be summed up:

A few words may be added in regard to the wireplant in large cities. It is, of course, possible to divide the city in sections and lay out each section in the manner just related. Such a proceeding, however, would prove very unsatisfactory, a better method being the one previously alluded to, namely, to take a map that covers the whole city and have a small square represent a block into which the present number of subscribers in the block are entered in black figures, and the future number of subscribers in red figures.

Then the process of laying out the wire plant will be the same as that just described; but in this case it will be out of the question to designate the number of open wires to be used from pole to pole; instead, an average number of such wires is assumed for the entire pole line in the street under consideration. In most cases the single poles are not recorded either, but the total number of poles in the street inserted, measuring the length of the street and assuming a certain number of poles per mile, say 44, which gives the number of poles that would be required for this street. Of course, when it comes to building the pole line a map is usually made of each street, and every pole located. The averaging of the open wires involve also the averaging of the cross-arms.

Wherever telephone pole lines are being

ESTIMATE OF WIRE PLANT FOR................................DATE................

....	25 ft. poles in place at $............	$............
....	30 ft. poles in place at $............	$............
....	35 ft. poles in place at $............	$............
....	40 ft. poles in place at $............	$............
....	45 ft. poles in place at $............	$............
....	50 ft. poles in place at $............	$............
....	guy poles in place at $............	$............
....	distributing poles in place at $............	$............
....	anchor poles in place at $............	$............
	Freight on above poles (if not included in above).	$............
....	cross-arms in place at $............	$............
....	insulators in place at $............	$............
....	ft. (or miles) of No.....B. & S. gauge copper (or iron) wire in place at $...... per ft. (or mile)	$............
....	ft. of 25 pair aerial cable in place at $............	$............
....	ft. of 50 pair aerial cable in place at $............	$............
....	ft. of 75 pair aerial cable in place at $............	$............
....	ft. of 100 pair aerial cable in place at $............	$............
....	ft. messenger wire in place at $............	$............
....	aerial house connections at $............	$............
....	ft. of 2-duct conduit at $............	$............
....	ft. of 3-duct conduit at $............	$............
	etc.	
....	ft. of 50 pair underground cable (No............ B. & S. gauge) in place at $............	$............
....	ft. of 100 pair underground cable (No........... B. & S. gauge) in place at $............	$............
(and so on up to 400 pair).		
....	ft. of laterals in place at $............	$............
....	ft of iron pipe in place at $...............	$............
....	manholes at $............	$............
....	house connections from underground conduits at $............	$............

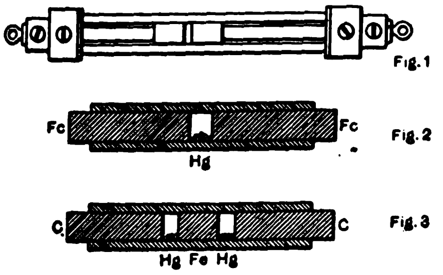
Note.—The cost of conduits to include also the cost of paving. The cost of aerial cables in place to include also the cost of the cable boxes, though the latter may also be charged to the distributing poles. To the above estimate sheet may be appended:

Incidentals and office expense..............................	$............
Engineering and supervision..............................	$............

erected, whether in the streets and alleys of a city, along country highways or across meadow lands or farms, they should be erected under fixed rules and regulations, clearly defined in rigid specifications. In city streets a more costly style of construction is demanded than along country roads; but both should be of substantial character in order to safely stand the maximum stress that may arise under abnormal atmospheric conditions, as well as the maximum strain due to unexpected increase in the number of subscribers' line the poles may be required to support. While telephone engineers formerly approved of placing as many as 25 cross-arms on a pole, later experience has shown the wisdom and economy of carrying not more than three 10-pin cross-arms on a pole, with the understanding that when there are 30 lines strung, these will be displaced by an aerial cable, leaving the open wires free for distribution. However, occasions will arise when it may be necessary to carry as many as 50 lines on a pole; hence due allowance must be made for maximum strains.

Abstracts from Foreign Contemporaries

Castelli Coherer. —The Italian naval authorities have carried out a series of experiments in wireless telegraphy with a view to testing the practicability of the system as a means of communication between the semaphore stations of the kingdom. These experiments, of which some account is given by A. Banti in *L'Elettricista,* were based on the Marconi system and the results obtained were somewhat disappointing until telephonic reception in combination with the self-decohering coherer, invented by Paolo Castelli, was tried. Coherers, as is well known, are formed in various ways, the most noteworthy being the so-called powder coherers, which may be made with silver electrodes and granules of carbon or silver, or silver and nickel. One of these tubes is shown by Fig. 1. The disadvantage of these tubes is that it is necessary to tap them for each wave received, in order to decohere them and render them capable of receiving another signal. But tubes or coherers having iron or carbon electrodes with a drop of mercury between them, as shown by Fig. 2, not only have a high degree of sensitiveness, but have the advantage of decohering completely as soon as the electric waves cease. The tube proposed by Paolo Castelli, shown by Fig. 3, consists of two carbon electrodes inclosing two drops of mercury separated by a small iron cylinder. When used in conjunction with a telephone, the receiving apparatus of the station becomes very simple, as shown by Fig. 4. In practice, the receiving arrangement is a somewhat more complete form, as shown by Fig. 5, which is simpler than previous arrangements. *G* is the bell, *H* is the relay, *A* the telephones, *R* the induction coil, *L*, a bell switch, and *E* a lightning protector. With a good tube, carefully adjusted, the e. m. f. of the cell should be from 1 to 1.5 volts. In the mercury tubes the self decoherence is more or less perfect, according to the purity of the mercury used, to the dryness and cleanliness of the interior of the tube, and to the smallness of the drop of mercury. The most suitable diameters of the drops are comprised between the extreme limits of 1.5 mm. and 3 mm. Drops less than 1.5 mm. are insensitive and those greater than 3 mm. diminish the completeness of decoherence. The diameters of the tubes must be proportional to the drops of mercury used. In general they are 3 mm. internal and 5 mm. to 8 mm. in external diameter. The new Castelli coherer in an improved form is stated to have been used by Marconi in his first attempts to signal across the Atlantic.



COHERERS.

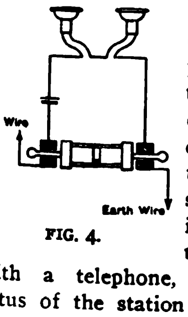


FIG. 4.

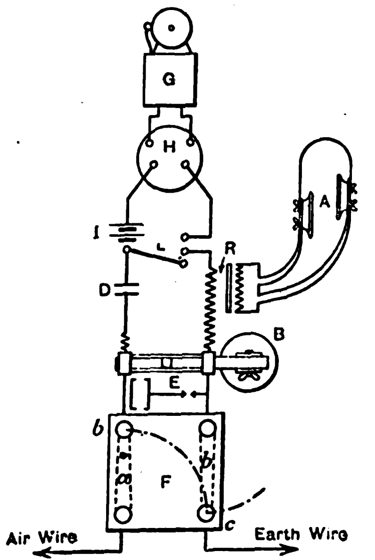


FIG. 5.—CASTELLI RECEIVING APPARATUS.

Lightning Arresters. —The *Elektrotechnische Zeitschrift* describes the system of lightning protectors made by G. Gola. Instances are given in which atmospheric discharges destroyed machines while the line was protected by ordinary lightning arresters and at times when there were no thunder storms. The ordinary lightning arresters showed no signs of having been acted upon and it was found that the discharge had gone from a wire of the armature to one or several pole-shoes; although this path was much longer than to any part of the earthed case and also much longer than the air-gap of the lightning arresters. It appears, therefore, that discharges of this kind are directed by a strong magnetic field, and that in such cases large air spaces can be overcome. To protect against discharges of this kind is the office of the new lightning arrester devised by G. Gola, shown by Fig. 6. It has the form of a hollow ellipsoid consisting of two halves of iron, *A B*, separated by a zinc frame, *F*. Above one half is another half ellipsoid of iron, *C*, so that there are two air spaces between the three iron pieces. In these a strong magnetic field is produced. Two pieces of carbon, *P*, are placed opposite to the rim of the ellipsoid, the distance being adjustable. The exciting coil, *H*, of the electromagnet is in series with the line. An atmospheric charge, which distributed itself over the surfaces of the apparatus is driven by the magnetic field to the rim of the ellipsoid and is caused to discharge over to the carbon pieces. These lightning arresters have been installed on a mountain line where, in five months, four accidents of the type mentioned had occurred, not withstanding the machines were protected by ordinary lightning arresters.

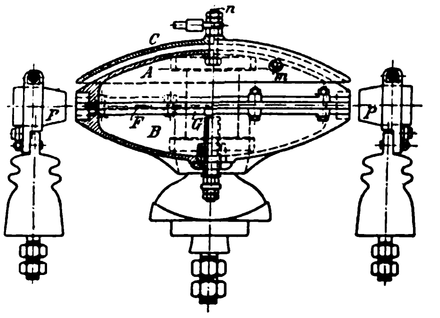


FIG. 6.—GOLA LIGHTNING ARRESTER.

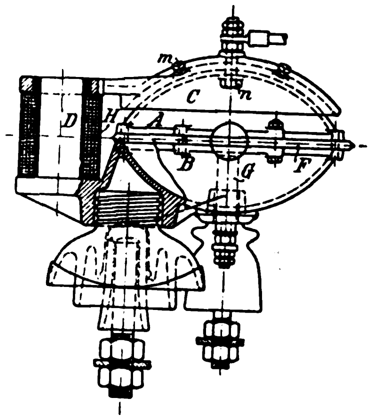


FIG. 7.—SIDE VIEW.

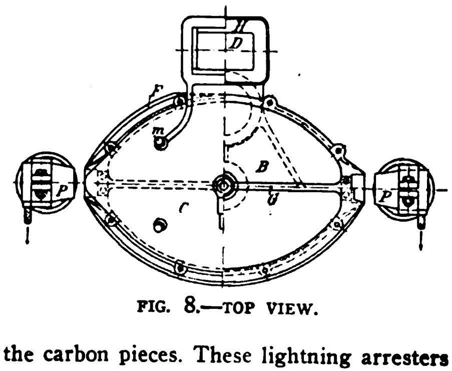


FIG. 8.—TOP VIEW.

Some Points in Switch Construction.—A. H. Mayes, writing for the *London Electrical Review*, expresses surprise that switches such as are ordinarily used for electric lighting and power installations should in many cases still retain the defects which characterize those of earlier construction. There is a marked want of proportion between the gap allowed between the switch contacts and the arc through which the contact maker is caused to pass when the switch is opened. In a typical case the distance between the contacts of a single-pole 25-ampere 250-volt switch was found to be 1⅛ inches, while the distance between the contact maker and the contacts when the switch was opened was 1½ inches. If an arc were formed on opening the switch it was certain to form between the switch contacts, since the only other path opened would be from one switch contact to the contact maker, then to the other contact, forming a double arc having a total length of three inches. From an extended use of this class of apparatus the author is of the opinion that the 1⅛ inches gap provided between the contacts in this specific case was insufficient, and that in breaking a current of 25 amperes at 250 volts an arc would frequently form. The author also maintains that the difference between the operation of single-pole and double-pole switches is not sufficiently appreciated, since it is common to find the same width of gap allowed between the contacts whether the switch be single or double-pole; the designers have apparently overlooked the fact that to be proportionate the gap of a single-pole switch should be twice that allowed in a double-pole switch, as in the latter case there are two spaces in the circuit for the arc to bridge over. Turning to the knife or chopper type of switch, the author finds a great deal of disparity between the dimensions and breaks allowed. When the switches are frequently used there is a liability of the nuts, etc., working loose owing to the difficulty of tightening them sufficiently against the brittle slate or porcelain bases used. This trouble could easily be overcome by placing spring washers where required. Where single-pole switches are coupled up in order to form double or triple-pole switches, trouble is often experienced owing to the unsubstantial nature of the coupling bar provided, while the handles frequently work loose. In place of the coupling bar of wood or fibre so often employed the author says it would be far more mechanical and satisfactory to fit a metal bar and to carefully bush all holes with ebonite in order to obtain the necessary insulation. This would also allow the handles to be fitted in a more substantial manner.

New Type of Direct-Current Arc Lamp—Frank Lewis contributes to a recent issue of the London *Electrical Review* a description of a direct-current double arc lamp designed by him in which a single mechanism controls the two arcs. The arrangement is such that when the current is off, each pair of carbons is brought into contact. The first action on switching on the current is to lock the upper carbons together in the position they take when striking the lower carbons, so that they are rigidly held together. The next action consists in their being drawn apart, thus striking both of the arcs. When the current is switched off the action is reversed, the carbons being unlocked from each other so that both pairs touch. We gather from this that the perfect action of the lamp presupposes that the carbons are consumed at the same rate. A cross-section of the lamp is given by Fig. 9 herewith. The lower carbons are fixed, one of them, marked *A*, being connected to the body of the lamp and the other, marked *B*, is insulated. A central tube to which the two lower carbons are fixed is shown, marked *C*. The two carbons are enclosed in a globe. The upper carbons are fixed into two spring carbon holders, one marked *D* being insulated from, and one marked *E* being connected to, the body of the lamp. The current is led through *D*, thence from the arc to the lower carbon *A* through the body of the lamp to the upper carbon *E*, through the arc and the insulated carbon *B* to the other terminal, so that the two arcs are in series. Each carbon-holder is linked to a lever *F*, to the spindle of which two discs, *K*, are rigidly fixed. This spindle is loosely pivoted in a cast-metal framework to which a rod, *G*, is fixed, which slides in the tube, *C*. On the framework of the casting four stops, marked *H*, are provided. A clutch, *I*, of similar type to those employed on the carbons of ordinary enclosed lamps is actuated by a solenoid through which the current passes to the arcs, and by the movement of the rod, *G* controls the lamp. The action is as follows: When the lamp is switched on the clutch, *I*, is pulled by the core of the solenoid, thus lifting the cast framework by the rod, *G*, and pushing up the stops, *H*. The discs are thereby locked and retain the carbons in the same position as they are when both pairs are touching before the circuit is closed. Any further movement of the clutch separates the carbons. As soon as the current is switched off the stops, *H*, unlock the discs.

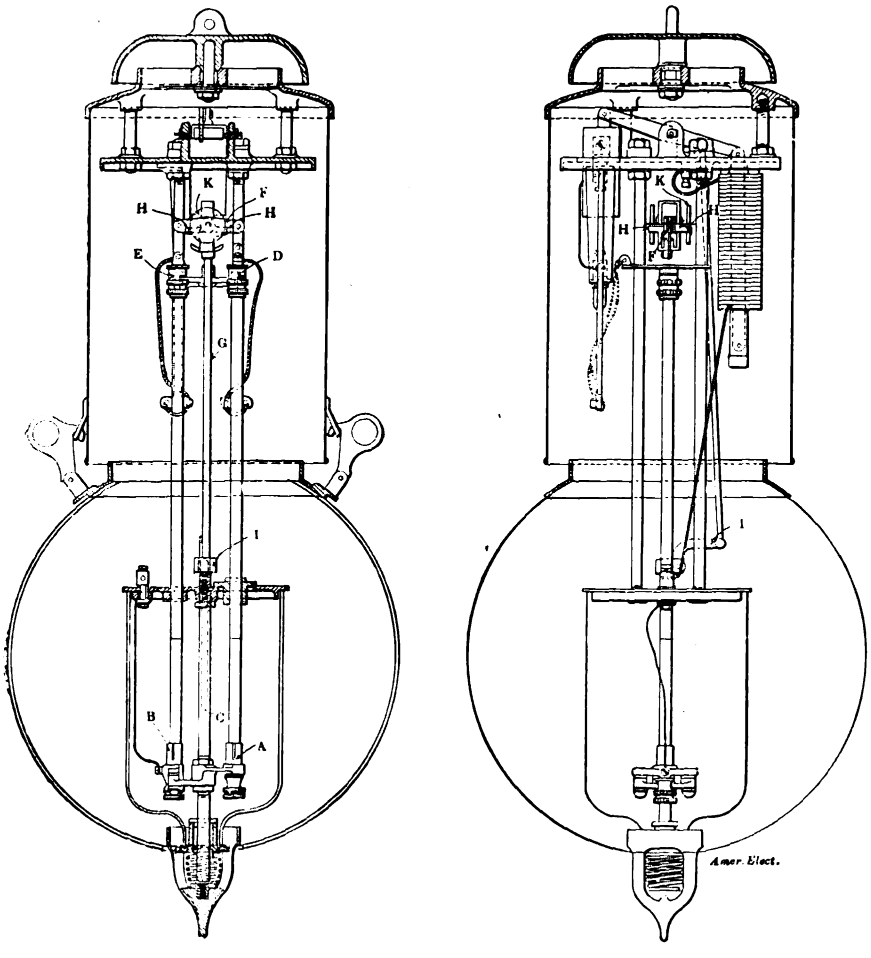


FIG. 9.—LEWIS DIRECT-CURRENT ARC LAMP.

Novel Feed Pump.—The accompanying illustrations, taken from the London *Mechanical Engineer*, show an arrangement of pump constructed by the Haste Pump Company, possessing some distinctively novel features. The suction and discharge pipes are placed on the bed-plate a short distance apart and directly in line with each other. Stuffing boxes are fitted to the inner ends of both these pipes and surround a short tube arranged to reciprocate in them. The tube is expanded in the center and contains a valve working on a guide which is free to open or close with the flow or movement of the water. When the valve is wide open, as shown by Fig. 10, there is an annular space around it equal in area to the area of the reciprocating tube, leaving a clear passageway for the water practically straight through the pump. When the valve closes it seats against the rounded edge of the tube, stopping up the annular passage and preventing the return of any water. Trunnions or pins are placed on the expanded portion of the reciprocating tube, to which connecting rods are attached leading to a crank placed at one end of the pump. As this crank is revolved, the connecting rods serve to reciprocate the tubes rapidly in the ends of the suction and discharge pipes. No air chamber is necessary and on heads up to fifty feet with small suction lift, no foot-valves or discharge valves are required; on higher suction lifts, however, a foot-valve is needed to allow of charging the pump when starting. After the pump is started this valve does not assist in the working, as there is a practically continuous flow of water through it. When pumping against high heads a discharge valve is needed to prevent knocking and the reversal of the flow of water when starting or when working at very slow speeds. When the pump is working at its normal speed, the valve is held wide open by the flow of water. In operation the action of the pump is practically as follows: On the forward stroke a vacuum is formed on the suction side of the valve and the water flows in, following the reciprocating tube, gaining in momentum as its velocity increases. At the end of the forward stroke the water has acquired sufficient energy to overcome the slight resistance of the valve and flows around into the discharge side of the pump, while the tube carrying the valve returns over the flowing column of water to its original position, ready to make another forward stroke. This action is said to be repeated so rapidly that the column of water never comes to a state of rest, but flows continuously. It is claimed there is no noise, shock or jar in handling the water, even at the highest possible speeds.

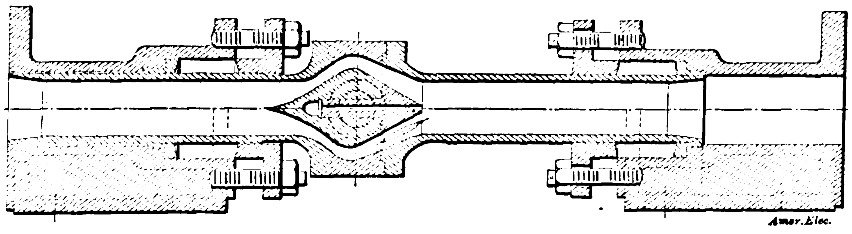


FIG. 10.—HASTE FEED PUMP.

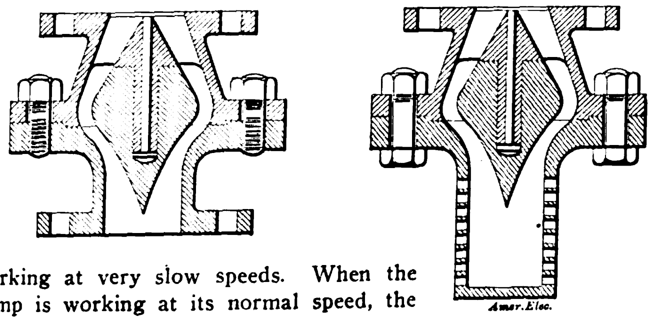


FIG. 11.—SECTION VIEW OF VALVES.

The Bremer Arc Lamp. —The London *Electrician* contains an abstract of a paper read before the Elektrotechnischer Verein of Vienna, by Siegmund Saubermann on the Bremer arc lamp. The Bremer arc lamp differs from others in two respects—the chemical combination of the electrodes, which contain calcium, silicon or magnesium salts, and their arrangement at an acute angle. The construction of the lamp is based on the phenomenon observed by a Geneva physicist, de La Rive, that the arc formed between two electrodes which are parallel or slightly inclined to one another is much greater than where the electrodes are on a straight line. In addition the well-known effect of electric currents in magnetic and electrostatic fields is made use of in order to obtain a particularly large arc. In other lamps this is of secondary importance, for the carbon points, and not the arc itself emit the main quantity of light. The volume of the source of light in the Bremer lamp is 200 to 250 cu. mm., while in ordinary lamps it ranges from 50 to 100 cu. mm., and it is apparently in this that the main cause of the greater intensity of light for the same consumption of energy lies; for the arc, consisting at it does, of white-hot conducting metallic oxides, offers no more resistance to the passage of current than the shorter non-luminous one. Fig. 12 shows the simple system of the apparatus, in which the carbons are pushed forward as they burn. In the illustration, *a* and *b* are tubes which guide the carbons; they have a slit through which the clamping checks, *k* and *k*, press against the electrodes; *k* and k_1 are insulated from one another and fastened on the pressure plate, *d*, in which two projecting metal-holders carry the arbor, *g*. The latter is in direct connection to the electromagnetic regulating mechanism, and by means of it the keeper, *f*, acts on the plate. While the lamp is burning the keeper, *f*, exerts a suitable pressure upon the plate, *d*, through the link, *g*, and this is conveyed equally to the two carbons. As the current through the arc decreases a differential or shunt current passes through one magnet coil, the magnet draws the keeper back, the pressure on the two carbons is diminished equally and they sink downwards. This decreases the resistance of the arc and the magnet comes out of action and allows the keeper to return to its former position. Several Bremer lamps may be connected in series, and as the two carbons are normally clamped fast in the manner above described they do not touch one another, and the arc is struck as follows: When the current is switched on, part of it passes through the relay and presses forward the keeper, allowing the carbons to slide down upon a metallic wedge which supports them. The main current then finds a closed circuit through this wedge and the shunt coils are no longer magnetized. Consequently, the carbons are once again clamped and the metal wedge, which is fixed to a movable lever, drops back of its own weight. Now the arc which is formed is subjected to the action of the series electromagnet, which drives it downward forcibly and the action becomes greater as the arc approaches nearer to the magnet by the burning away of the carbons. The increased deflection increases the resistance of the arc, the magnet is exerted to a still greater extent, and acts on the carbon feed, as already described. In direct-current lamps only the positive carbon need be impregnated with the salts. Fig. 13 shows the arrangement of the differential winding and is self-explanatory, and Fig. 14 the simple shunt-wound electromagnet acting as a blower. For the sake of clearness the arrangement of the lever arm and carbon holder is omitted in these illustrations; *a* and *a* in Fig. 14 are the two electrodes connected with the mains, and *e* is the magnet, which is in shunt. The carbon ends project into a conical reflector, which throws

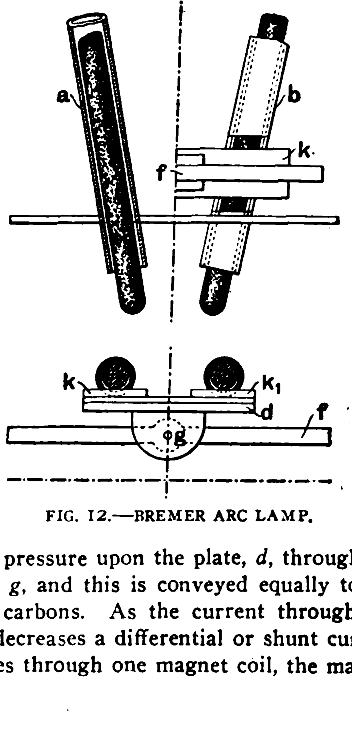


FIG. 12.—BREMER ARC LAMP.

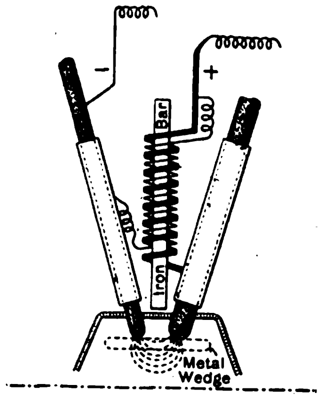


FIG. 13.—BREMER ARC LAMP.

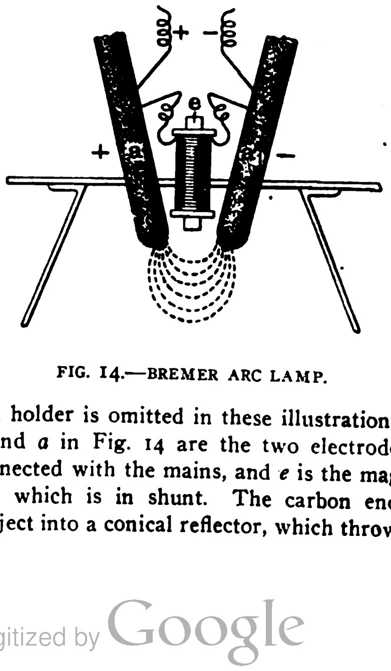


FIG. 14.—BREMER ARC LAMP.

the light produced downward, and in this it is assisted by a dazzling white coating of lime and silica acid, which is continually renewed upon it. In addition, the reflector also acts as a sort of reservoir to the hot gases which are developed, by which higher temperatures are obtained by retaining the heat near the carbons, and a slow consumption of the carbons is caused by the lack of oxygen, the hot gases sheltering the carbon ends from the air. Fig. 15 is a diagram showing the distribution of light, plotted from figures obtained in a test made by Prof. W. Wedding at the Charlottenburg Technical College, and shows to what extent the conical reflector assists in the illumination.

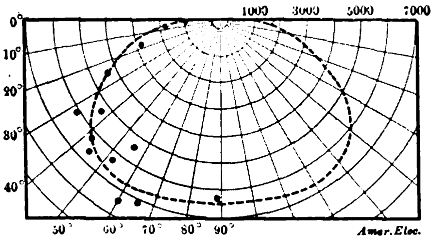


FIG. 15.—DISTRIBUTION OF LIGHT.

Some Recent Electrical Patents

Safety System for Rotary Converters.—A rotary converter operated in the ordinary manner, that is to say, taking power from an alternating-current circuit and delivering power to a direct-current circuit, will run in synchronism with the frequency of the alternating current supplied, and its speed will change only with changes in that frequency. There are several causes, however, which tend to produce excessive and destructive speed in the rotary converter. It sometimes happens that the alternators supplying current to the machine speed up abnormally, and it is also true that the alternating-current supply mains are sometimes interrupted. In the first case, the rotary speeds up, of course, in conformity with the increase of speed by the alternators. In the latter case, if the rotary is connected at the direct-current end to a circuit supplied from other sources, it is driven as a motor from that circuit, and if the machine is provided with a series field winding, which is commonly the case, the field strength is reduced by the reversal of current through that winding, and the speed of the machine will increase abnormally. On the other hand, if a rotary converter is operated inversely, that is to say, taking power from a direct-current circuit and delivering to an alternating-current circuit, the speed of the machine is affected not only by variations in the e. m. f. of the direct-current line, but also by changes in the character of the load supplied from the alternating-current side of the machine. For example, if the alternating-current load is inductive, the lagging currents react on the field magnets of the rotary and weaken them, causing the machine to speed up, while a condensive load will have the opposite effect through the reaction of the leading currents from the rotary converter field. In order to provide a remedy for these disadvantages, Chas P. Steinmetz has devised the arrangement shown diagrammatically in Fig. 1. The armature of the rotary converter is indicated by *R*, the field magnet being omitted for simplicity; *a b* are the direct-current wires, in one of which is inserted a circuit-breaker, *f*. The alternating-current supply wires, *i*, *j* and *k*, are protected in two legs by circuit-breakers, as shown, and are bridged by a branch circuit including the windings, *M*, of a switch, a condenser, *C*, and, if necessary, an inductance, *N*. All three of the circuit-breaker coils are connected in parallel to the battery, *Q*, when the electromagnetic switch, *M*, is closed. The inductances and capacity in the circuit containing the magnet, *M*, are so proportioned with respect to each other as to bring that circuit into a state of resonance when the frequency on the alternating-current side of the converter mains is such as to render it desirable to disconnect the rotary converter. By means of this arrangement it is obviously possible to adjust the tuned circuit so that the current in that circuit will be a maximum at any predetermined abnormal speed at the rotary converter (and, consequently, abnormal e. m. f.); the magnet, *M*, is adjusted to respond to this maximum current in the tuned circuit and throw all of the circuit-breakers, disconnecting the converter from both the alternating-current and the direct-current circuits. Patent No. 701,958.

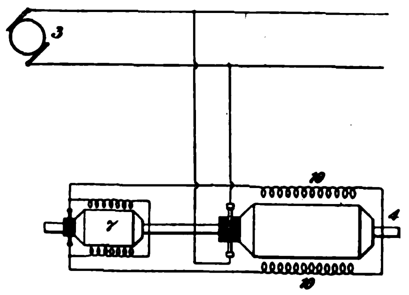


FIG. 2.—MOTOR SPEED REGULATION.

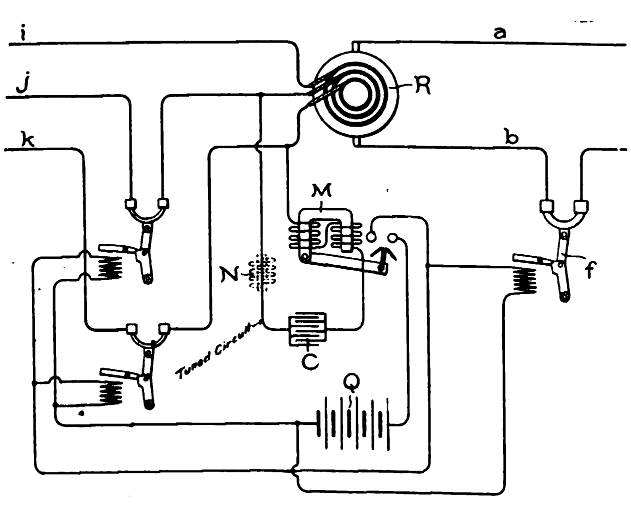


FIG. I.—SAFETY SYSTEM FOR ROTARY CONVERTERS.

Motor Speed Regulation.—Fig. 2, herewith, illustrates a peculiar arrangement devised by B. G. Lamme for obtaining approximately constant speed in a motor supplied from a circuit of variable electromotive force. The motor armature, 4, receives current in the usual manner from a generator, 3, but its field winding is excited from an auxiliary dynamo, 7, which is direct-driven by the motor itself. The field magnet of this auxiliary dynamo is worked at a low degree of saturation, so that the e. m. f. at the brushes is approximately proportional to the field excitation. Any increase in speed by the motor, therefore, increases the e. m. f. at the brushes of the dynamo, thus strengthening the field excitation of the motor and checking its speed increase. It is not explained how the field magnet is excited upon first starting up when the dynamo cannot supply any current, but this is presumably done by connecting the motor field winding temporarily to the main supply circuit and switching it over to the auxiliary dynamo after the motor attains normal speed. Patent No. 702,657.

◆

Standardization of Advertising Literature.

To the Editor, American Electrician:—

Probably the greatest inconvenience experienced by those obliged to retain the numerous catalogues which are received, is caused by the fact that there are so many different sizes. There is really no good argument in favor of this large variety of shapes and forms other than, perhaps, the artistic effect which is occasionally secured.

For flyers the size should be made 3½ inches by 6 inches, but when it comes to standard catalogues where they cover lists, code words, etc., that are expected to be referred to from time to time and must be filed for reference, it is extremely essential that the 6-in. x 9-in. size of book be considered if the best results are to be secured.

We have on file in our office about 3500 catalogues and pamphlets, and I find that there are more than 500 different sizes. It is self-evident that to file these catalogues so that they will be convenient for reference is a most difficult matter, and if they are not filed so that they can be conveniently referred to the manufacturers represented are the losers. It would seem, therefore, that this fact alone would cause manufacturers to think well before they decide to use a mongrel size when making a catalogue.

Three sizes have been decided upon by, I believe, a committee appointed by the steam railroads a number of years ago, namely 3½ x 6, 6 x 9, and 9 x 12. If all literature conformed to these three sizes the files of those who are obliged to keep them would be vastly improved, and it would facilitate the finding of data concerning any particular product to an incalculable extent. The saving in time alone would be a very large item. Many times, owing to the fact that catalogues have not been properly filed, days are sacrificed writing for a duplicate copy, and an order is lost to a manufacturer that would have otherwise received the business had his literature been available.

Since coming with this company I have rigidly adhered to standard sizes for all publications. I have never had occasion but in one instance to use the 9 x 12 size. All of my bulletins are made 6 x 9 inches and flyers have been 3½ x 6. These two sizes when proper attention has been given to the preparation of cuts would serve almost any purpose. Of course there are cases where, perhaps, the 9 x 12 size would be the more desirable, but at any rate there seems to be no good excuse for departing from these three sizes.

I believe that if the trade press of this country would take the matter up vigorously through their editorial departments and by drawing the attention of manufacturers to the subject in various ways, it would finally result in standardizing this class of literature, and the gain to manufacturers both to the seller and to the purchaser would be very great indeed.

I have sent this communication to numerous other publishers, and would like to see this subject continuously in sight in one form or another until the desired result has been secured. FRANK G. BOLLES.

Bullock Electric Manufacturing Company.
Cincinnati, Ohio.

NOTES.

Reduced Rates for Electrical Service in New York.—The New York Edison Company has just announced a reduction in the maximum price of current for incandescent and arc lighting to take effect on September 1. This reduction is made possible by the splendid facilities for the production and supply of current in the new Waterside Station.

The daily average use of each entire installation connected with the meter and service wires, excepting fan motors and heating appliances, will continue to determine the rate of the monthly charge. The future schedule of prices will be as follows:

Average Hours of Use..	Per Kilowatt Hour	Per Arc Lamp Hour (500 watts)	Per Incandescent Lamp Hour (50 watts)
First and Second	15 cents	7½ cents	¾ cent
Third and Fourth	10 cents	5 cents	½ cent
Fifth and Sixth	7½ cents	3¾ cents	⅜ cent
All over six hours	5 cents	2½ cents	¼ cent

The present records of the installation will continue to serve as a basis of determining the average use of current until notice is given in writing of any changes or corrections.

Scanty Water in California.—The low water in the streams flowing from the Sierra Nevada mountains in California is causing some uneasiness to the big power companies. Measurements taken at Jelly's Ferry on the Sacramento river July 5 showed a flow of only 1,180 cu. ft. per second as compared with 4,617 cu. ft. per second last year. The other rivers of the state show a similar falling off.

American Electrochemical Society.—The following members were elected at the July meeting of the board of directors: Chas. P. Steinmetz, Schenectady, N. Y.; George M. Brill, Chicago, Ill.; Edward L. Anderson, St. Louis, Mo.; Loren Gleason Waite, New York; Arthur Clarke Melcher, Newton Centre, Mass.; David Pepper, Jr., Philadelphia, Pa.; Wm. F. Doerflinger, Niagara Falls, N. Y.; Chas. M. Thomas, Nutley, N. J.; Henry E. Grunet, Basel, Switzerland; Dr. G. G. Pond, State College, Pa.; Edgar F. Price, Niagara Falls, N. Y. The total membership of the society is now 365.

Vermont Electrical Association—Representatives of the electric lighting interests of the State of Vermont, on July 9, held a meeting at Bellows Falls, Vt., at which there was organized the Vermont Electrical Association, the aims and character of which are similar to those of the various State organizations composed of electric lighting and power representatives. The new organization elected the following officers: President, Harry Bottomley, of Bellows Falls; Vice-President, C. F. Thompson, of Brattleboro; Second Vice-President, M. Patterson, of Fair Haven; Secretary and Treasurer, C. C. Wells, of Middlebury, and an Executive Committee composed of E. E. Larrabee, of Bennington; E. B. Blackwell, of Brandon; E. E. Gage, of St. Johnsbury; G. S. Haley, of Rutland, and F. Barney, Jr., of Springfield.

Postal Telegraph Extensions.—A rumor to the effect that the telegraph lines of the Pennsylvania Railroad Company are to be withdrawn from the Western Union Telegraph Company and turned over to the Postal Telegraph Company was not officially confirmed until after the transfer actually took place, on July 1. This change gives the Postal Company control of 4,745 miles of lines and about 3,000 offices, the total business of which is estimated at about $750,000 a year. The contract is for a term of 15 years, and under its stipulations the Postal Company has to pay a rental of $70,000 a year and 50% of the cash receipts from commercial business. The railroad company retains the right to free telegraph service to the extent of $100,000 a year. The Postal Company will also obtain control of the Long Island Railroad Company's lines when the contract between the Long Island Company and the Western Union expires.

Developments in and Around Portland Oregon.—The Oregon Water Power & Railway Company, Portland, Oregon, which recently succeeded the Oregon General Electric Company, has acquired the ownership of all the street railway lines, power plants and other property owned by the Portland City & Oregon Railway Company in and around Portland. The new company announces that all the work begun by the Oregon General Electric Company will now be carried out. The plans include the construction of a power station on the Clackamas River and a trolley line from the new plant to Portland. It is stated that $5,000,000 will be spent in the proposed developments.

Northwestern Electrical Association.—The —The summer convention of this association was held June 25 to 27 inclusive at Grand View Hotel, Chain-o'-Lakes, near Waupaca, Wis. The convention was chiefly of the nature of an outing for the central station and electrical supply men who attended, so that there was not very much serious work done. A paper on "Small Motors," was read by M. S. F. Dibble, of the General Electric Company's Chicago staff. The paper was largely historical, discussing the methods employed in handling small motor business in the early stages of the industry, and the growth of that branch of business, together with the improvement in the character of the small motor.

World's Fair Airship Contest.—The Louisiana Purchase Exposition has appropriated $200,000 for an airship competition and exhibition; one-half of this sum is offered as a grand prize; $50,000 has been appropriated for minor prizes for competitions between airships, balloons, airship motors, kites, etc., and the remaining $50,000 is to be reserved for expenses incidental to the competition. The competition for the prize of $100,000 is open to every one without limitation as to the power used or the mechanical principles involved, but no applicant will be admitted who cannot present satisfactory evidence of having at some time made a flight of at least one mile and return with a machine similar in principle to that which he proposes to use in the competition. Each vehicle in this contest shall carry at least one person during its flight, and shall not require any permanent and visible connection with the earth or which is not absolutely free after the start has been made. The course over which the contest will take place will be L-shaped, and the length of the entire course will not be less than 10 miles nor more than 15 miles. The grand prize will be awarded to the competitor whose average speed during his three fastest trips around the course shall be greatest under the rules. Complete information concerning the contest may be obtain from Willard A. Smith, chief of the department of transportation exhibits.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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The Induction Motor on Lighting Circuits.

At the recent electric light convention the somewhat frayed question of the operation of induction motors on lighting circuits was the subject of considerable discussion, most of which had the familiar ring of an oft-told tale. Solemn consideration was bestowed upon the same class of experiences that have received the same solemn consideration periodically for about five years past. Only a very small part of the discussion escaped this general characterization. The explanation of the odd display of perfunctoriness, lack of advancement, or whatever one chooses to term it, is simple—there is nothing in the behavior of the standard induction motor that has not been perfectly well known for at least five years; consequently any discussion of its operation under ordinary conditions must necessarily comprise mere reiteration or variation of previous discussions.

As we have pointed out several times during the past year or two, the characteristics of the induction motor as operated under ordinary central station conditions have been so thoroughly investigated and made public so often that there is really no more reason to discuss them than to consider the behavior of an ordinary direct-current motor. There is no mystery or complexity about the operation of the machine. It requires a starting current anywhere from one-half its full-load running current to several times that current, according to the method of starting up. Consequently, one of two things must be done: the method of starting must be chosen with regard to the circuit on which the machine is to run, or else that circuit must be laid out with regard to the starting current required by the motor.

The fact is that induction motors should be built to take as small a starting current as possible without sacrificing other features abnormally. This means, of course, some sacrifice of simplicity in construction. The "squirrel-cage" is a beautifully simple piece of machinery, and it is but natural that its adherents should be loath to modify its simplicity by inserting starting resistances. Nevertheless, this is the only policy that will give the induction motor the universal utility, regardless of circuit or regulation considerations, that is characteristic of the direct-current shunt motor. For purely power circuits, "squirrel-cage" motors with primary voltage regulation are all that can be desired, if very frequent starting is not necessary. For general service, however, a good rule to lay down and follow inflexibly is that "squirrel-cage" machines shall not be operated from lighting circuits unless there is a most liberal allowance of copper between each motor and the supply station; and that when so operated they should never be allowed to start under any load whatever.

◆

Developing a Power Service.

In cities of considerable size, where there is an ample day-lighting load to justify twenty-four-hour operation, the problem of developing a power service is relatively simple. In the first place, no particular size of load is absolutely necessary in order to obviate operation at a loss during the missionary period. In the next place, it is a matter of small inconvenience and expense to "demonstrate" to the skeptical power user the practicability of the electric motor. Under such conditions, probably the best plan is to put in a motor, without charge to the customer, and let him use it a month on probation—paying for the current, of course. We have never known of an experiment of this kind that was not successful.

One of the first principles of establishing a power service is to convince the prospective customer as to the amount of power his engine is actually developing. The next step is to prove to him what his power is costing. A large majority of small power users will ignore a hundred and one incidentals, the aggregate of which adds a very respectable amount to the more prominent items of fuel, water and wages. Finally, when it comes to actually installing a motor, or several of them, the customer should be strongly urged to put in an equipment that is more than sufficient for his present needs, and should be allowed to make his own selection, if he so desires, from a list of thoroughly reliable makes, and to purchase direct from the manufacturer, if he prefers that course. It is an extremely short-sighted policy to attempt to exercise any control in the matter of purchasing motors, beyond insisting that some one of several standard makes shall be used in order to insure satisfaction to the customer and a minimum amount of expert attendance.

In the discussion of this question at the recent electric light convention, one or two speakers advocated a flat installation charge to compensate for operation at small loads. We know of no surer method of discouraging a prospective motor user. Motor loads are almost invariably day loads in plants of moderate size, and for such loads the method of charging should be the very simplest that can be devised—a plain, straight meter rate. The customer should pay for every particle of equipment within his premises, and having done that he is not to be blamed for balking at any frills and complications tacked on to his service charge, such as "readiness to serve," "idle factor charge," "capacity charge," or other illogical intricacies.

The plan of renting motors has been tried with varying results, both here and in England, but it appears to have very little in its favor and a great deal against it. About the only point of advantage is that it may enable a small establishment to become a power customer that would otherwise not be obtained because of the outlay necessary for the motor. We do not believe that such customers are ever of much consequence to a central station.

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Grounded Secondaries.

On another page we print a short discussion on this subject that took place at the recent National Electric Light Convention, and from which it would appear that there is an unaccountable diversity of judgment among central station men on this point. It is rather surprising to find such conflict of opinion on a subject that was supposed to have been thoroughly threshed out by special and specially competent committees at previous conventions. And when one reflects that it was only by dint of the most energetic work by representatives of the National Electric Light Association that the National Board of Fire Underwriters was persuaded to approve the practice of grounding secondaries, the present discussion appears inconsistent, if not stultifying. It does not augur well for future progress with the underwriters to find the National Electric Light Association using all its influence to obtain official approval of a practice the advisability of which it subsequently casts doubt upon by making it a subject for debate.

Like almost every other question of electrical working, the grounding of secondary circuits has both favorable and unfavorable features. On general principles, a ground on any electrical circuit is obnoxious, even when deliberately applied. It puts an abnormal strain on insulation, and makes possible the infliction of shocks which could not be received if the circuit were absolutely insulated. The magnitude of the "if" in this last proviso, however, practically nullifies the objection that depends on the proviso for its own validity; an absolutely-insulated electric light circuit would be a freak. There is the further objection that grounding the neutral of a three-wire secondary circuit would be likely to cause the destruction of lamps on one side if the outer wire on the other side became grounded, the ungrounded side being thus subjected to the full outer-to-outer potential.

The three disadvantages just cited constitute the whole basis for serious objection to grounded secondaries. On the other hand, there is the paramount advantage of greater safety to life and property in the event of a leak from primary to secondary in a transformer. No aggregate of disadvantages, however real and expensive, can possibly offset this single feature of protection to life. Abnormal insulation strains can be met readily enough by adequate insulation; the liability to shock exists anyhow, as pointed out above, no circuit being so thoroughly and permanently insulated as to evade it; the danger of smashing a few lamps by a double ground may be very greatly reduced by properly fusing the neutral wire at branches and individual lamp circuits at tablet boards. The objection offered by one speaker at the convention, that his fixture insulating joints succumbed to the strain, is easily met by obtaining decent insulating joints. In short, there is not a solitary objection to grounded secondaries that cannot be eliminated by raising the standard of insulation and construction to the proper level.

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Conductance and Susceptance.

Most students find it perfectly easy to understand what is meant by "conductance" in direct-current working, but become greatly perplexed on reaching alternating-current phenomena to find that conductance is no longer the numerical reciprocal of resistance, and are still further perplexed to find that "susceptance," which is the opposite property to reactance, is not the reciprocal of that property. The explanation is simple for anyone who is familiar with the trigonometrical relationship between resistance, reactance and impedance. This relationship is best expressed by means of the formula, $\sqrt{\text{Resistance}^2 + \text{Reactance}^2} = \text{Impedance}$. Now, the reciprocal of impedance is "admittance," and admittance is the combination of conductance and susceptance in precisely the same way that impedance is the combination of resistance and reactance, thus: $\sqrt{\text{Conductance}^2 + \text{Susceptance}^2} = \text{Admittance}$. A numerical example will serve to show clearly why conductance and susceptance cannot be the reciprocals of resistance and reactance, respectively.

Suppose a magnet coil to have a resistance of 6 ohms and a reactance of 8 ohms; then its impedance will be $\sqrt{6^2 + 8^2} = 10$ ohms, and its admittance will be the reciprocal of this, or 0.1. The conductance is ascertained by dividing the resistance by the square of the impedance, thus: $6 \div 10^2 = 0.06$; and the susceptance is similarly ascertained by dividing the reactance by the square of the impedance, thus: $8 \div 10^2 = 0.08$. These values may be checked by means of the formula, $\sqrt{\text{Cond.}^2 + \text{Suscep.}^2} = \text{Admittance}$, thus: $\sqrt{.06^2 + .08^2} = 0.1$, which is the value of the admittance as shown above. In the assumed case, therefore, we have the values, resistance = 6; reactance = 8; impedance = 10; conductance = 0.06; susceptance = 0.08, and admittance = 0.1, from which it will be evident that conductance and susceptance cannot be the reciprocals of resistance and reactance and still preserve their proper relation to admittance, which is by definition the reciprocal of impedance.

When receptive devices in an alternating-current circuit are connected in series with each other, only their resistances, reactances and impedances need be considered, but when they are connected in parallel, the joint impedance of the group is most easily found by first finding its admittance by combining the individual admittances, and then reducing admittance to impedance. For example, if two inductive devices, such as arc lamps with series magnets, be connected in series, their total impedance may be ascertained by adding their resistances, adding their reactances, and then adding the squares of the two sums and taking the square root of the result. Thus, if one device has a resistance, R, and a reactance, X, and the other one has a resistance, R_1, and a reactance, X_1, the total impedance of the two will be $\sqrt{(R + R_1)^2 + (X + X_1)^2}$. With the two devices in parallel, however, this method cannot be used. The respective conductances and susceptances must be deduced by the method indicated in the preceding paragraph, and these can then be combined to give the total admittance in the same way that the resistances and reactances were combined into impedance when in series; having the total admittance, its reciprocal is the joint impedance.

WIRELESS TELEGRAPH APPARATUS.

The Induction Coil.

BY WM. A. DEL MAR.

Instructions for building a reliable induction coil giving a spark at least three inches in length are here given. A larger coil is used by Marconi in all his work, but this size will be found adequate for the needs of most amateurs.

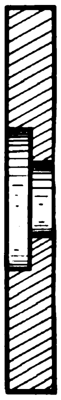

FIG. 1.

The first consideration is the iron core. This must be of high permeability; that is to say, it must be susceptible of a high degree of magnetization with a small current in the primary. It must have little retentivity, or power to retain residual magnetism when the current is stopped, and it must require little coercive force to remove its residual magnetism. These properties are found combined in pure annealed soft iron wire. A further advantage attained by the use of wires instead of a rod, is that a little insulation between the wires is sufficient to stop eddy currents which would otherwise lower the efficiency of the coil and give rise to excessive heating. The core is made in the following way:

Pieces of No. 20 iron wire 12½ inches long are tied into a bundle with thin wire. The bundle is then enclosed in an iron pipe, the ends and superfluous space of which are filled with clay or plaster. It is then put in a coke or coal fire and left there until the fire is out and the embers cool. This is to insure very slow cooling. When cold, the wires are removed from the pipe, sand-papered to remove superfluous oxide, and then dipped in boiling water, wiped dry, and coated with thin shellac varnish while still warm. The wires are packed into a tube of hard fibre of 1¼ inches internal diameter, ⅛-inch thick and 12 inches long, so as to project at one end only.

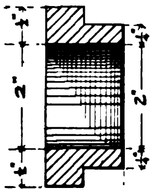

FIG. 3.

Two blocks of ebonite or hard rubber, 6½ inches square and ½-inch thick are next prepared and a hole 2 inches in diameter is bored half way through the center of each. A hole of exactly the diameter of the outside of the fibre tube is then drilled all the way through, so that each block appears in section, as shown in Fig. 1. Five holes an inch apart are drilled and tapped in the edge of each block to receive the screws which fasten them to the base. These screws should not have a diameter of over one-quarter of an inch. The fibre tube should now be glued into the hole in one of the blocks, so as to be flush with the outside edge, as shown in Fig. 2. The other block is not needed until a good deal more work has been done.

Three layers of No. 16 double silk-covered wire are now wound on the fibre tube and one end of the wire taken out through the small hole, *A*, Fig. 2. A similar hole is drilled in the other block when it is time to put that on. The winding is carefully varnished with shellac, each layer being allowed to dry before the next is put on. When this is done, a micanite tube 11½ inches long, 2 inches in outside diameter, and with a wall about ⅛-inch thick, is glued into the larger hole in the other ebonite block, and an ebonite ring, of the dimensions shown in Fig. 3, is glued onto the tube and block. A similar ring is made for the other end, but it is not glued on. This completes the bobbin and primary coil. The finished parts are shown in part section in Fig. 4.

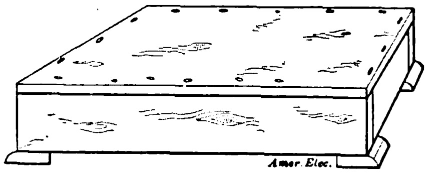

FIG. 5.—BASE FOR INDUCTION COIL.

The next thing to attend to is the base. This is best made of well-seasoned mahogany about ¼-inch thick. It is shown in perspective in Fig. 5, and the details of construction are shown in Fig. 6. The various pieces, with their dimensions, are shown in Fig. 7. They are fastened together by means of corner pieces and hard glue. The fitting must be done very accurately in order to obtain a good looking job.

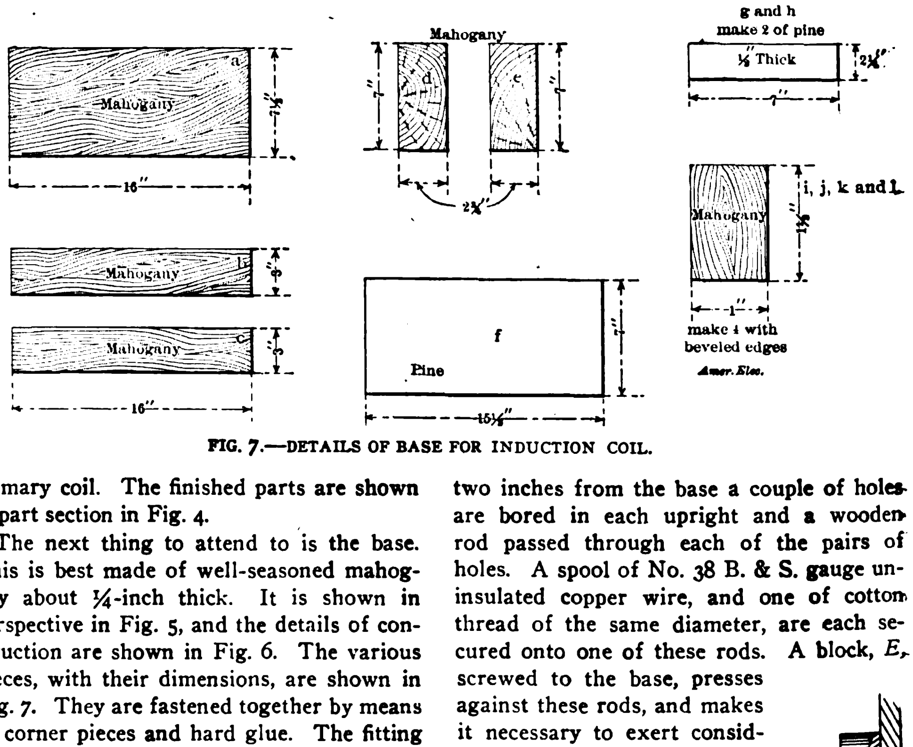

FIG. 7.—DETAILS OF BASE FOR INDUCTION COIL.

For making the secondary coils a winding spool must first be prepared. This, as shown in Fig. 8, consists of a brass tube of 1 15-16 inches diameter and a pair of adjustable brass cheeks of 6½ inches diameter, which clamp onto it. The inner faces of these cheeks must be parallel and smooth. Near the center of the tube drill a small hole, to be used for holding the end of the wire during winding. The cheek pieces must be adjusted so that the distance between the inner faces of the cheeks is one-half inch, and the hole in the tube is at the inner edge of one of the cheeks. It is not necessary to wind the secondary with insulated wire. If the consecutive turns are insulated from one another by cotton thread and the consecutive layers by paper, very good insulation is obtained.

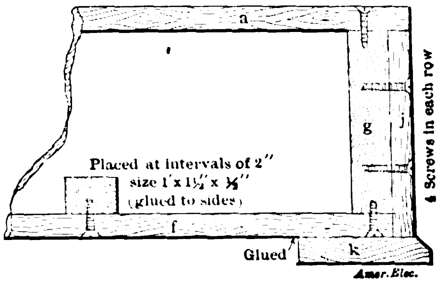

FIG. 6.—SECTIONAL VIEW OF BASE.

The winding is effected by means of a simple winding device, which is shown in Fig. 9. A wooden board, *A, B*, has two uprights, *C* and *D*. The tops of these uprights are deeply grooved so as to hold the brass bobbin, as shown in the illustration. About two inches from the base a couple of holes are bored in each upright and a wooden rod passed through each of the pairs of holes. A spool of No. 38 B. & S. gauge uninsulated copper wire, and one of cotton thread of the same diameter, are each secured onto one of these rods. A block, *E*, screwed to the base, presses against these rods, and makes it necessary to exert considerable pull on the thread and wire to turn them. A stationary rod, *F*, connects the two uprights and carries a needle, *H*, which serves to keep the wire and thread apart. When the brass bobbin is turned around, the wire and thread wind on side by side.

Before winding is commenced, paper is

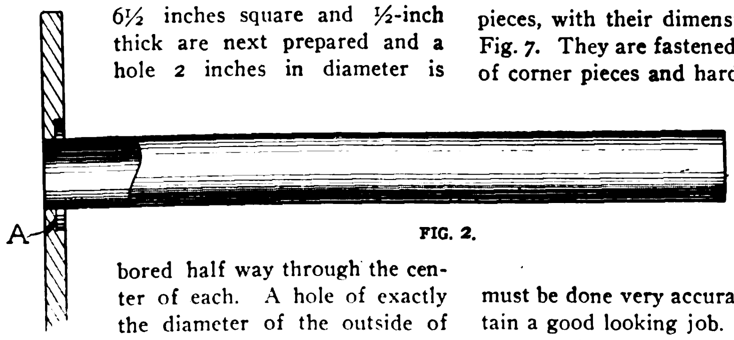

FIG. 2.

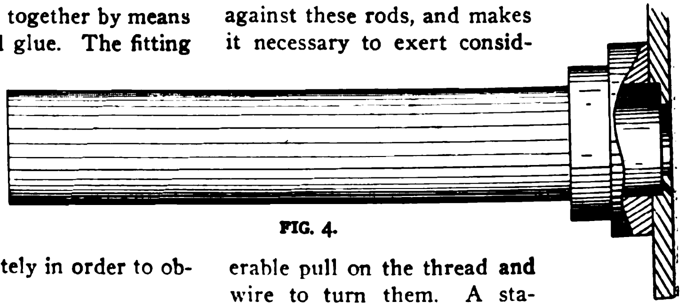

FIG. 4.

wound around the brass tube to a depth of somewhat over one-sixteenth of an inch, and the end of the wire to be wound on stuck through the hole and fastened to the tube. The wire and thread are then wound on evenly, side by side, until there is one complete layer. This layer is brushed over with shellac varnish and a strip of rather thin paper put over it and varnished also. Another layer of wire and thread is wound over the paper and varnished as before, and in this way alternate layers of paper and thread-separated wire are put on until the diameter of the wound part is 6 inches, or, in other words, until the depth of the winding is 2 inches. A current may be kept going through the wire while winding, so as to indicate on a galvanometer whether there is any break in the circuit. Care must be taken that the wire is not twisted and that there are no kinks in it.

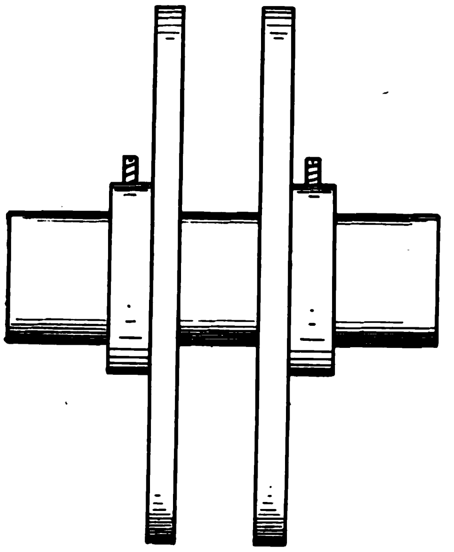
FIG. 8.—WINDING SPOOL.

When the winding is complete, the bobbin is allowed to dry in the open air and then put in an oven and thoroughly dried under moderate heat. The brass cheeks are then removed, the inner end of the wire loosened and the coil slipped off the tube. All except a couple of layers of the paper that was put on the brass tube are taken out of the center hole of the coil and the latter is again varnished and slowly dried in a warm place. A good varnish for this purpose is made as follows: Put one ounce of shellac into a wide-mouthed 8-ounce vial containing 5 ounces of rectified naphtha. Cork and stand in a warm place until the gum is dissolved. Shake frequentlty and filter through cloth, adding more naphtha to assist the filtering.

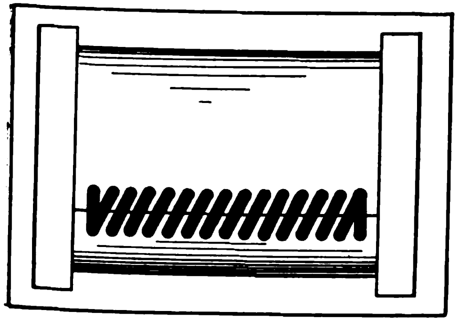
FIG. 13.—LACED COVER.

It is next necessary to put terminals on the coil. The outer terminal is a piece of ordinary flexible wire such as is used for electric lighting, but divested of its outer cotton or silk insulation. This piece should be about 1 inch long. The inner terminal consists of a piece of thin sheet copper ¼ inch square soldered to the wire as near as possible to the coil. In this way 20 sections or coils are made, but they are not all made 2 inches deep. Two are made of each of the following depths: 2 inches, 1⅞ inches, 1¾ inches, 1⅝ inches, 1½ inches, and 1¼ inches; four are made 1 inch deep, and two are made 1⅝ inches deep, but with a central hole of 3 inches diameter, and two 1⅞ inches deep with a central hole of 2½ inches diameter.

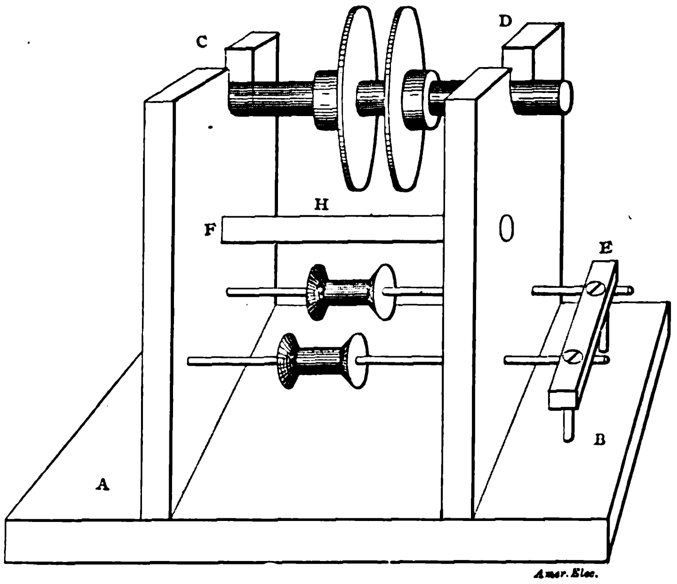

FIG. 9.—WINDING DEVICE.

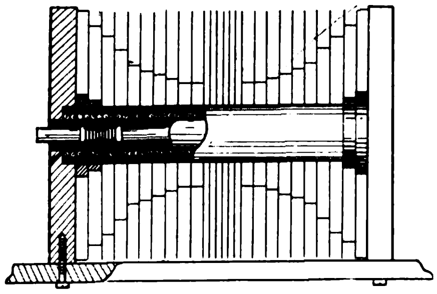
FIG. 12.—SECTION OF COIL.

These coils with larger central holes are made by putting brass rings on the winding tube. One of these rings is ¼ inch and the other ½ inch thick, and both are ½ inch wide with central holes of 2 inches diameter. All the sections must be wound in the same direction and the terminals of the wire must be in the same relative position in all. If the outside terminal be on the left, the inner one will be on the right, as shown in Fig. 10.

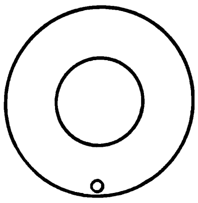
FIG. 11.

Before the sections can be assembled it is necessary to prepare the ebonite insulating rings. These are made of 1/32-inch ebonite, 6⅜ inches in diameter with a central hole of 2 1/32 inches diameter. In each of these discs is a 1/16-inch hole about ⅛ inch from the outer edge; 18 of these and two with 2 17/32-inch central holes are required. One of the discs is shown in Fig. 11.

Before assembling the coils it is first necessary to permanently join them in pairs, and to do this the following pairs of coils are picked out; one 2 inches deep and one 1⅞ inches deep; one 1¾ inches deep and one 1⅝ inches deep; one 1½ inches deep and one 1¼ inches deep; and one 1 inch deep and another 1 inch deep. There are two of each of these. As all these pairs are made alike, a description of one will do for all. The two coils are placed together with their inner terminals towards one another and are separated by one of the 18 ebonite discs, as shown in Fig. 11. The little copper terminal plates are carefully soldered together, care being taken that no superfluous solder remains. The coils are then glued to the ebonite disc by means of a small quantity of the following cement:

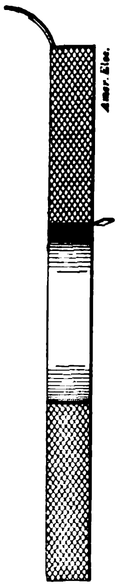

FIG. 10.

Sulphur	100 parts
Tallow	2 parts
Resin	2 parts

Melt these together to a ruddy syrup, add sifted ground glass to form a paste, and heat when used.

Two other pairs of coils must be prepared. These are made up of one coil with a 3-inch central hole and one with a 2½-inch central hole. These coils are separated by an ebonite disc with a 2 17/32-inch hole. They are made in the same way, except that the leaf-copper terminals are joined by a short wire soldered to both.

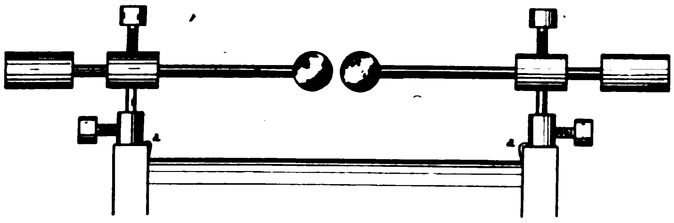
FIG. 14.—SPARK-GAP AND ATTACHMENTS.

The assembling of the coils is accomplished in the following way. One of the last described pairs is put on the step-like ebonite ring which was glued to the end cheek of the bobbin and to the micanite tube. An ebonite disc is then slipped on the tube and next to that the 2-inch—1⅞-inch pair. Then comes another ebonite ring and next to that the 1¾-inch—1⅝-inch pair. Again there is an ebonite ring and then the 1½-inch—1¼-inch pair. A disc is placed next to that and is followed by a 1-inch—1-inch pair. Each of these pairs is turned with the larger coil of the two towards the end cheek, so that the coils slope down from the ends toward the center of the induction coil. After the 1-inch—1-inch pair are placed two discs, and after that the following pairs with discs between them are put on in the order given:

1-inch—1-inch,
1¼-inch—1½-inch,
1⅝-inch—1¾-inch,
1⅞-inch—2-inch,
3-inch central hole—2½-inch central hole.

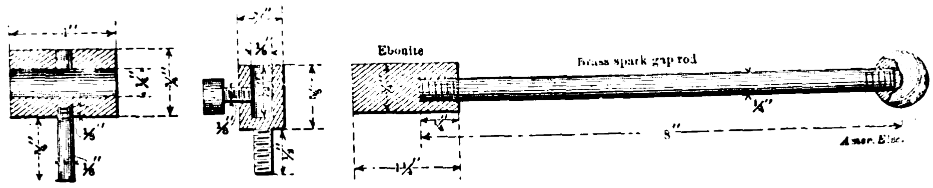

FIG. 15.—DETAILS OF SPARK GAP PARTS.

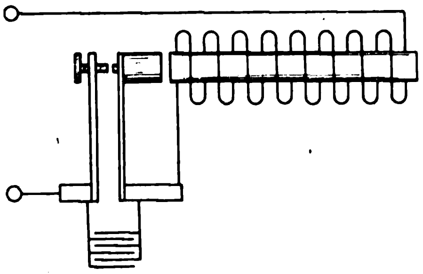

FIG. 16.—DIAGRAM OF CONNECTIONS.

The second step-like mica ring is then slipped under the last pair and finally the whole micanite tube put over the primary winding and slipped into the recess in the ebonite head to which the primary winding is attached. The loose end of the latter winding is brought through the hole, *A*, in the head to which the secondary winding is attached. The two heads are then screwed onto the mahogany base and the whole appears as shown in Fig. 12. The projecting outside terminal wires of the secondary coils are passed through the 1/16-inch holes in the ebonite separating discs and twisted together.

The winding is then covered with a sheet of thin ebonite bent all the way around and laced through perforations with black silk ribbon, as shown in Fig. 13. The laced portion is slipped around underneath the coil so as to be out of sight. The end terminals of the secondary winding are brought over the edges of the heads, as shown in *a a* in Fig. 14, and screwed down by the terminal and spark-gap attachments shown in that illustration. The details of these parts are shown in Fig 15.

There now remains nothing to describe but the accessories of the primary circuit. These are the condenser, contact-breaker, and binding posts. The connections of the primary circuit are shown in Fig. 16. The condenser is made in the following way: First cut 150 sheets of tinfoil 10 inches by 6 inches, and 160 sheets of paraffined paper 10 inches by 7 inches. Then make a pile of alternate sheets of paper and tinfoil until there are 25 sheets of tinfoil. In this pile, alternate sheets of tinfoil project one inch at opposite ends, as shown in Fig. 17. When this is done, the pile is heated until the paraffined wax begins to run, and is then put between a couple of boards and pressed until the wax hardens. All the projecting tinfoil ends at each side are soldered together. The outside faces of this condenser are protected by a couple of sheets of paraffined paper. In this way six condensers of 25 sheets each are made, and placed in a pile with paraffined cardboard separators 10½ inches by 7 inches. All the groups of tinfoil ends are soldered together on one side, but left free on the other. Each of the six free sets of tinfoil sheets is soldered to a bare No. 18 B. & S gauge copper wire 3 or 4 inches long.

The paraffined paper must be made of thin, close-grained paper and must be carefully searched for pin-holes before and after immersion in the wax. As the tinfoil sheets are in multiple, a pin-hole in one sheet of paper will spoil the whole condenser. The wax must be very dry and must not be heated to over 130° F., or used remelted. A suitable quality of paper is the thin bond used for foreign correspondence.

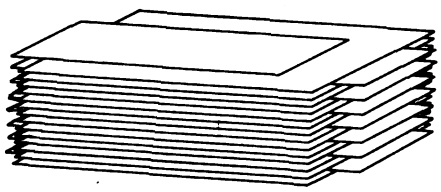

FIG. 17.—CONDENSER.

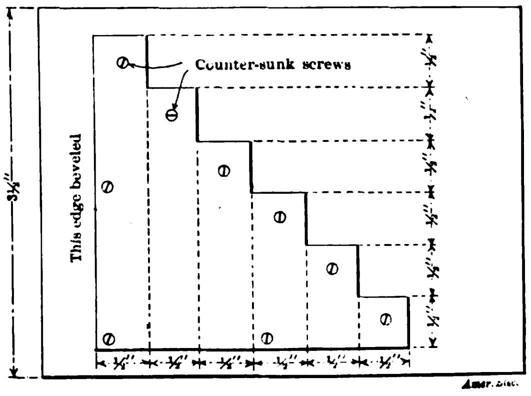

FIG. 19.—CONTROLLER.

It is next necessary to provide some way of putting more or less of these condensers in multiple so as to be able to vary the capacity to suit the primary current. The device which accomplishes this is shown in Fig. 18. It consists of six brass springs, each soldered to one of the condenser wires, and a revolvable wooden cylinder having a steplike copper sheet on it. A view of the cylinder as it would look if it were a plane, is given in Fig. 19. The cylinder has a brass rod running through it, which serves as a pivot above and below. Above the base this rod is screwed into a round ebonite

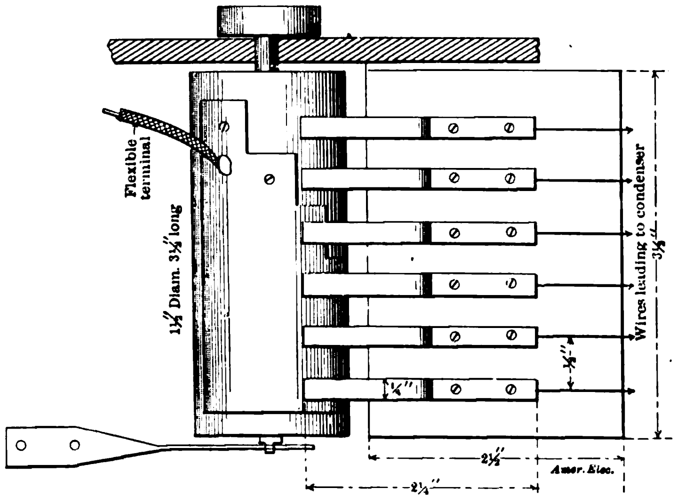

FIG. 18.—CONTROLLER.

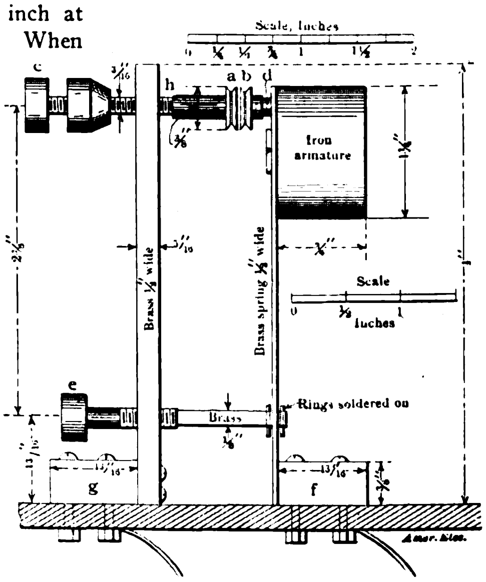

FIG. 20.—CONTACT BREAKER.

knob, and below it fits into a hole in a brass hanger. The springs are screwed to a wooden block, which is glued to one side of the interior of the base. The wires from the condenser must be fastened by staples to the interior of the base so as to prevent them from getting into contact with one another and with other wires.

The contact-breaker is a most important part of the coil and on its proper construction the success of the coil largely depends. The form recommended is the mercury break apparatus described in the AMERICAN ELECTRICIAN for June, 1902. A contact-breaker of the platinum contact type is, however, here described. A peculiarity of this form of platinum contact-breaker consists in the use of a considerable area of platinum foil at the contacts. There are two copper plates, *a* and *b*, Fig. 20, which are soldered to brass coil springs, as shown in the illustration. These copper plates have platinum foil stretched over them and bound on at the edges by thin wire. The other end of the coil spring carrying the plate, *a*, passes through a hole at *h*, in the brass screw, *c*. This screw extends into the spring to within ⅛ inch of the copper plate, *a*. There is a similar, but shorter, spring on the short rod, *d*, which carries the platinum-covered plate, *b*. These springs must be capable of about 1/16-inch compression under the force of the flat brass spring carrying the iron armature. Fine and coarse adjustment are obtained by the use of the screws, *e* and *c*, respectively. A couple of large binding-posts complete the equipment. An e. m. f. of about 12 volts is required to operate this coil. Six small storage cells or quart bichromate elements are recommended.

ENGINE TESTS.

BY H. F. SCHMIDT.

There are but few engineers who are in charge of power plants who realize the importance of keeping a proper engine room record, and making engine and boiler tests at frequent intervals, the results of which are carefully preserved in the engine room record book. These tests should be as simple as possible, and yet contain all the information that is of daily practical value to the engineer and which will lead to the more economic running of the plant.

Two of the most important points to be observed in making tests of any kind whatever, are the making of proper records of all data, and keeping the object of the test constantly in mind, both of which will prevent much loss of time and lessen the liability of making errors. This is best done by having cards or sheets made out and ruled before the test begins, having a space for each of the readings to be taken, and also for the date, duration and object of the test. Many tests have been ruined by neglecting this seemingly unimportant point, for after the test is once under way, there will be no leisure time to rule data sheets, etc. The chief should instruct the assistants in their duties, and they should be clearly understood by them before beginning the run, in order to save time and trouble, and to obviate as far as possible all chance of making mistakes.

The following remarks refer and apply only to such practical tests as should be made from time to time by the engineer in charge of the plant, therefore all refinements such as would be observed in a test for scientific research have been omitted.

The length of the stroke, diameter of the cylinders and the diameter of the piston rod or rods should be carefully measured. The volume of the clearance spaces, which must be known, may be found by setting the engine on the dead center and weighing the water required to be poured in the indicator tap hole to fill the space. If the weight is found in ounces and divided by 1000 (998 more nearly) the result will be the volume of the clearance space in cubic feet. The clearance at each end of the cylinder should be found separately, as the clearance is seldom if ever the same at both ends.

Before beginning the test all steam and vacuum gauges should be compared with a standard gauge, as also the indicator springs which must be compared at the temperature corresponding to the steam pressure; a failure to do this may lead to an error of from five to six per cent. All thermometers must also be tested for the freezing and boiling point, as thermometers of reliable make have been known to vary by two or three degrees after having been in use for a number of years.

The reducing motion to be used should be tested for its accuracy. This may be done by dividing the travel of the crosshead into any convenient number of equal parts, and then moving the engine through an entire revolution and observing at each mark on the guides to see if the indicator card has moved through the same proportional part of the stroke. Should the indicator reducing motion be inaccurate the cards would be distorted, making it almost impossible to find the steam consumption from them, and also making it very difficult to tell the condition of the valves and the point of cut off. It will also be well to see if the cord stretches at high speeds, as stretching will also distort the diagram.

Speed indicators and, if possible, a reliable tachometer should be provided and adjusted before the test is commenced.

If the plant runs condensing, the water condensed should be weighed in barrels or a reliable water meter should be used to determine the volume, from which the weight can be calculated, knowing that a cubic foot of water weighs 62.4 lbs.

The engine should be in good running order and the piston and valves should be tested for leakage, which if appreciable should be remedied before the test is started.

In order that the test may be a fair one, a calorimeter of either the throttling or throttling-separator type, (the throttling type preferred where the conditions permit its use) must be attached to the steam pipe where it enters the steam chest, or to the steam chest direct.

The horse-power developed may be determined either by a prony brake or, as most of the engines in charge of readers of this paper are connected to dynamos, by the output of the dynamo, the efficiency of which can be obtained from the efficiency curve furnished by most manufacturers upon request.

The test should be of at least one hour's duration, during which time ten sets of readings should be taken, making the interval between readings six minutes, which is just enough to allow everything to be done properly, and the data to be carefully recorded.

Having the indicators attached, the springs adjusted to suit the speed, calorimeter, gauges, tachometer and revolution counter all properly attached and working smoothly, the test may be begun.

The engineer in charge will take the calorimeter and steam gauge readings and the indicator cards in as rapid succession as possible, while the attendants will take the tachometer, vacuum, gauge, weight and temperature of the condensed steam and if a prony brake is used, its scale reading. If the engine is driving a dynamo, one of the assistants will take the voltmeter and ammeter readings, though a wattmeter is preferable.

The assistant will also make a record of all data, doing all the clerical work, as the chief will be busy with more important work and should not be disturbed. After an interval of six minutes the same readings will be again taken.

If a prony brake is used to measure the horse-power developed the formula:

$$H.\ P. = \frac{2\pi PLN}{33000} = .00019\ PLN$$

may be used, in which N is the number of revolutions per minute; P the pull in pounds, and L the length of the lever arm in feet.

When the out-put is to be determined from the dynamo it can be found from the relation:

$$H.\ P. = \frac{\textit{Amperes} \times \textit{Volts}}{746 \times \textit{Efficiency of Dynamo.}}$$

the efficiency of the dynamo being ascertained as previously described.

Knowing the developed horse-power the weight of the condensed steam (in a condensing plant) and the duration of the trial, the number of pounds of steam per horse-power per hour is obtained. The steam consumption can also be calculated from the indicator card, as will be shown later.

Having found the mean effective pressure by means of a planimeter the indicated horse-power can be calculated by means of the familiar formula:

$$I.\ H.\ P. = \frac{PLAN}{33.000}$$

This should be calculated for both

ends of the cylinder independently and the two results added, giving the total indicated horse-power. The reason why this result should be calculated separately for each end instead of simply multiplying the result for one end by two; is that the area of the two ends differs by the area of the piston rod and the mean effective pressure is seldom if ever the same at both ends of the cylinder.

The weight of the steam present in the cylinder at any point between cut-off and release can easily be found from the indicator card. Hence if we find the weight of the steam present just after cut-off has taken place and multiply it by the number of strokes per hour (taking each end of the cylinder separately for the reasons already given) the result will be the weight of the steam used per hour, neglecting that lost due to cylinder condensation during admission. The method of making this calculation is as follows:

Just about at the point of cut-off, a line is drawn across the indicator card at right angles to the atmospheric line and the pressure at this point accurately measured. Then the portion of the entire stroke traversed by the piston up to this line is found and reduced to a fraction of a foot, which is then multiplied by the area of the piston in square feet. To this add the volume of the clearance space in cubic feet; the result will be the cubic feet of steam in the cylinder at the point of the stroke where the vertical line was drawn. If this sum is then multiplied by the weight of one cubic foot of steam at the given pressure, the result will be the weight of the steam in the cylinder. The weight of a cubic foot of steam can be found from any of the published tables of the properties of saturated steam. Now multiplying the steam per stroke by the number of revolutions per hour will, of course, give the steam consumption per hour in that end of the cylinder.

This is all right when there is no compression, but in most engines there is a certain volume of steam left in the clearance at the end of each stroke, so that this must be subtracted from the amount of steam as given by the above calculation. The weight of steam in the clearance space is found in exactly the same way as just described. The pressure at the end of compression is accurately measured on the indicator card and the weight of a cubic foot of steam at this pressure is then found in the table. The volume of the clearance space is then multiplied by this and by one half the number of strokes per hour, which will then be the total amount of steam left in the clearance space per hour.

The average steam per indicated horse-power per hour can be found by dividing the total weight of steam per hour as ascertained by the foregoing method, and also by the time of the run, and multiplying by sixty.

If the weight of the steam is also found at the point of release, the difference between the steam present at cut-off and at release will be the amount lost by cylinder condensation, and where the cylinder is jacketed it may be of interest to note the difference in cylinder condensation with and without the jackets in use; hence if the pressure in the jacket is found and the jacket water weighed, it is a simple calculation to find out whether or not the jacket steam is paying for itself.

Where the steam is condensed and weighed it will be necessary to compensate for the quality of the steam furnished the engine. This is done by finding the amount of moisture present in the steam by means of a calorimeter, and subtracting this from the total weight of the condensed steam. The method of calculating the amount of moisture in the steam is fully explained in the December, 1901, and the January, 1902, numbers of the American Electrician.

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GROUNDED SECONDARIES.

A "Question Box" query at the recent Electric Light Convention as to the desirability of grounding alternating-current secondaries brought forth a number of opinions. Mr. R. J. Patterson, of Waterville, Me., said he believed it to be impracticable, if not impossible, to maintain a ground sufficiently good to protect from accidents, and that even if that difficulty were overcome it would still be a question whether or not the same expense could be better applied in providing proper precautions to prevent accidents by so arranging that grounds could not be made by users with ordinary care. Grounding puts an unusual strain upon the transformer insulation, especially in lightning storms, and if it must be done, Mr. Patterson considers that the customers should do it and maintain the ground. His company has entirely abandoned the practice of grounding the secondary, owing to its unfavorable experience.

Mr. F. L. Sargeant considered it very important to ground the secondaries, as in the case of a cross between the primary and secondary lines it would prove a protection to the houses, and also in the case of a breakdown between the primary and secondary windings. Mr. James E. Pyle, Westchester, Pa., was opposed to grounding where overhead lines are used. He said his company had had several fires on account of the grounded system. When one wire becomes grounded there is a good chance to set fire to a roof, if it is also grounded on a wire of different polarity, as when a service wire is pulled down by any cause, or becomes crossed with a telephone or telegraph wire that may be pulled across the main, or break and fall on a service wire. Another source of trouble with the grounded system is the burning of insulating joints on fixtures. Mr. Pyle's company has had much trouble from joints giving out through fixture wires becoming grounded on the fixture, in which case the joint is sure to ground soon after. He thought it feasible to keep the entire system free from grounds.

Mr. W. J. Greene, of Cedar Rapids, Iowa, favored grounding of secondaries, but awaited results from such practice before coming to a definite conclusion. Two secondaries grounded on his system recently, but no trouble resulted; since then several storms have occurred, in which a number of transformers, recently grounded on one leg of the secondaries, were burned out. The writer of an anonymous communication said he had not availed himself of the right to ground circuits as permitted by the underwriters' rules, for he feared it would lead to carelessness on the part of employees. Should a house become grounded, instead of removing the ground, it would be a very natural thing simply to throw the ground on a leg of the secondary system. Aside from this fact, however, he believed that grounding is a wise precaution, and should be adopted.

Mr. P. Junkersfeld said that his company favors the grounding of the neutral on one leg of the secondary system, since it offers better protection to life and property. If one leg is properly grounded the maximum potential between any secondary wire and the ground is practically limited to the lamp voltage, since, in the case of a breakdown between the primary and secondary there is a path to ground through the grounded secondary terminal. With an inter-connecting secondary system, electrostatic capacity might be troublesome and even dangerous, but it is entirely eliminated by grounding one terminal. In Chicago it is a comparatively easy matter to establish a good ground by burying a copper plate at the time the pole is set, or by driving a 1-inch gas pipe to a depth of, say, 6 to 8 feet.

Mr. H. H. Scott, of Lincoln, Neb., considered that if one of the three wires of a secondary system is to be grounded, it should be the neutral, for in this case it is only possible to get 110 volts on a 110-220-volt system in case of a breakdown causing accidental ground on either of the outside wires. Several other central station men agreed in this.

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FORCE-FEED LUBRICATORS.

BY JAMES F. HOBART.

Only a very few years ago, the engineer kept an earthen crock on top of the boiler, in which a piece of suet slowly melted out its tallow. That was for cylinder lubrication through a small direct-feeding closed cup attached direct to the steam chest or supply pipe. For bearing lubrication, there was the supply of lard, also of sperm oil. Nothing in the lubricating line was known to the engineer, except a mixture of fish-oil, tar and some other substances for daubing the teeth of slow-moving gears.

Oil cups were almost unknown then. There was the traditional oil hole, which had to be dug out with a wire when the lubricant was applied; frequently the oil hole was in a wooden box and the oiler used the tang of a file to remove the accumulated dirt so as to admit oil. It used to be a frequent occurrence to find a bearing heating badly, or even catching fire from internal friction caused by a bit of steel from the tang of the file wherewith the oil hole had been opened.

The careful engineer whittled pine plugs and with them closed the oil holes from dirt. That was the beginning of the development of the lubricator, which has now reached a great degree of perfection. The pine plug in the open oil hole, and the screw-closed tallow cup with a stop valve for closing the steam pipe connection, have given place to elegant and efficient designs that are now found upon the crudest and cheapest engine or machine on the market.

In briefly describing the working of the various lubricating devices, a commencement will be made with the cylinder lubricator, thence leading up to the journal lubricating devices. Fig. 1, the plain cylinder oil cup, is pretty close to what the old-school engineers had to get along with, on both large engines and small. To use this primitive cup, the horizontal stop valve was first closed, then the vertical plug on top of the cup would be removed and the oil or tallow poured in, after which the plug would be replaced and the stop valve opened a trifle to permit the required amount of oil to pass into the cylinder. And many a time, in the writer's experience, has the oil all gone into the cylinder in one grand rush, to the discomfort of the engineer and the discredit of oil cups in general and that one in particular.

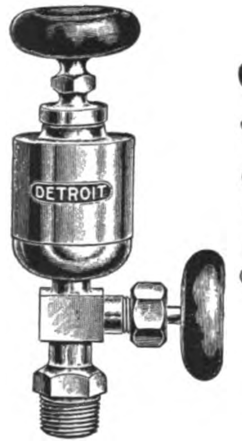


FIG. 1.

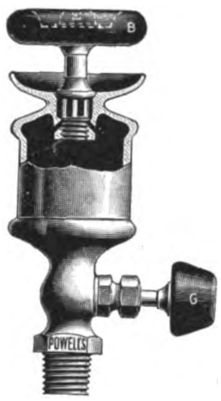


FIG. 2.

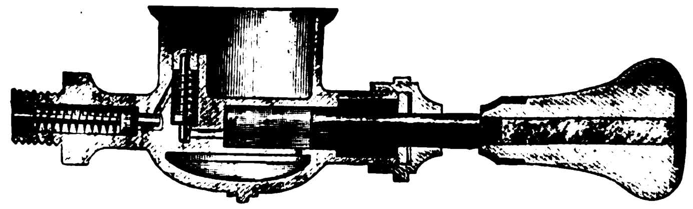


FIG. 3.—HAYDENVILLE LUBRICATOR.

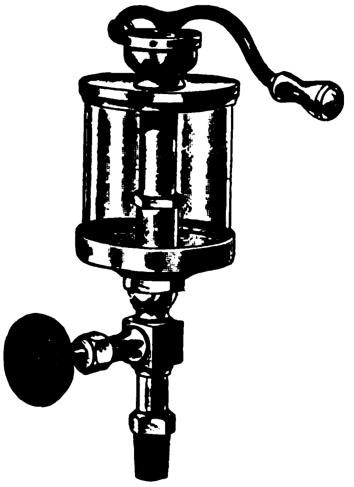


FIG. 4.—HAND-PUMP LUBRICATOR.

Any engineer who has used the earlier forms of plain lubricators will readily understand the discomfort connected with the use of a cup which had its regulating valve stem so close to the hot steam chest that it was usually impossible to operate the adjusment without burning or pinching the fingers severely unless great care was taken during the operation. Fig. 2 shows how this trouble was eliminated; also how filling the cup was made an easy task instead of a disagreeable, oil-wasting job. The stem of the cup was elongated so as to raise the regulating valve high above the hot surface and leave the fingers plenty of room. And as the top of the cup forms a funnel into which the oil is easily poured, the plug does not have to be entirely removed during the filling operation. It is screwed up a few turns, and there remains during the filling operation and is never lost or damaged by a fall during the process. The oil cup here shown is the product of the Wm. Powell Company, Cincinnati, Ohio.

The plain cylinder lubricators are necessarily so uncertain in their action, that it was a natural step to improve them by the addition of a hand pump in order that a certain amount of oil could be positively delivered into the cylinder at the will of the engineer. Fig 3 shows the application of a pump to an open oil or tallow cup, as made by the Haydenville Manufacturing Company, Hadenville, Mass. The construction of the pump cylinder is such that a partial vacuum is formed during the reverse stroke of the plunger, to the effect that when the admission ports are uncovered, the oil is forced by atmospheric pressure into the pump chamber with considerable force, thus securing a positive filling of the pump chamber.

The next logical step in the development of the hand-pump lubricators for cylinders was to place the pump in the spindle of the oil cup and to make the barrel of the cup of glass instead of brass, as shown in Fig. 4. The adjusting valve is high up, away from heated surfaces, and the upper part of the cup spindle forms a convenient funnel for receiving oil from the filling can. These cups are also made to meet certain conditions, with the pump plunger horizontal and with the stop valve stem at right angles thereto. It will be noted that the pump lubricator shown by Fig. 3 has no stop or adjusting valve. The check valves in the pump itself do all the work of the stop valve. The work of this class of pumps, now-a-days, is mainly to supply oil quickly to the engine in case of emergency, the regular lubrication being performed by automatic sight-feed devices, which will be described later.

Naturally, the next step, after a good hand-feed pump had been secured, was to connect the pump with some moving portion of the engine, thereby making the system continuous, automatic, and capable of taking care of the cylinder as long as the oil cup was kept properly filled. Fig. 5 shows such a modification in a mechanically-driven oil-pump, which can also be operated by hand whenever more oil is necessary. The valves are supported by the upper portion of the cup, thus making the moving parts independent of temperature changes. The two parts of the cup are held against the glass by means of studs in such a manner that tightness is secured, while the valve mechanism can be readily removed for inspection without disturbing the connections. It will be noted that the reciprocating parts of the pump are driven by a rocking mechanism, which is easily kept free from lost motion and is easily adjustable for wear. Adjustment for rate of lubrication is provided by the several holes in the pump lever, giving several points of attachment for the connecting link, and correspondingly different travels for the lever. Means are provided

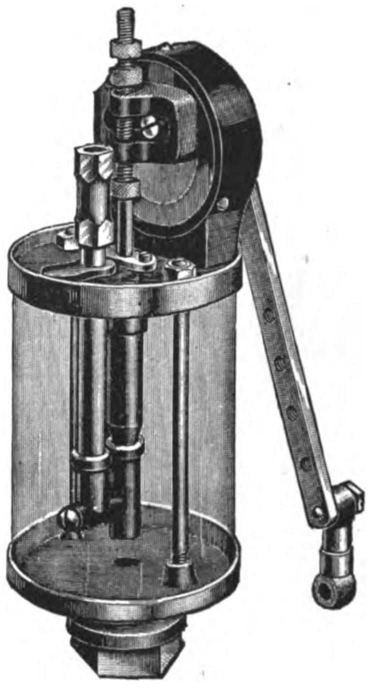


FIG. 5.—AUTOMATIC LUBRICATOR.

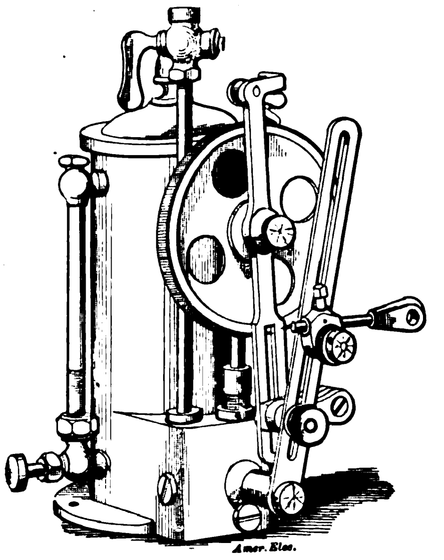


FIG. 6.—ROCHESTER LUBRICATOR.

for cleaning out the cup without breaking any of the screw connections.

Another form of force-feed lubricator, known as the "Rochester," is shown by Fig. 6, in which the oil delivery may be graduated from one to twenty-four drops per stroke of the engine or pump. There is a compound-lever motion combined with a ratchet movement which permits a very fine adjustment of feed to be made. Although the device shown in the engraving is a single feed lubricator, they are made double, triple, or quadruple, with a separate adjustment to each delivery, so that while one is furnishing two drops of oil per stroke, one of the others may be sending out a dozen drops, another three drops or a single drop, as required. The valves are arranged without springs, and a special check valve is provided in the oil pipe in order to prevent trouble in trying to deliver oil into a low-pressure cylinder, or even into a vacuum chamber.

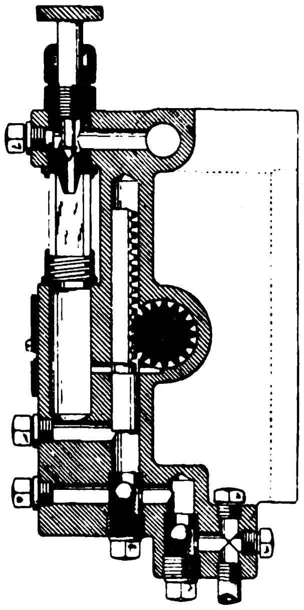


FIG. 7.—SIGHT-FEED OIL PUMP.

This lubricator is designed to feed oil against any pressure up to 1,000 pounds per square inch, the valves, both for inlet and discharge, being double in order to ensure tightness. The glass tube shown in the engraving is an ordinary gauge glass to show the amount of oil in the lubricator reservoir. In this device, the pump is of the plunger variety and is driven from the engine by a cam. At each revolution of the cam, a quantity of oil is discharged into the cylinder by means of a separate arrangement on the piston of the pump, whereby a separate stroke and return stroke of the plunger is made, no matter how short the stroke may be. It is manufactured by the Rochester Automatic Lubricator Company, Rochester, N. Y.

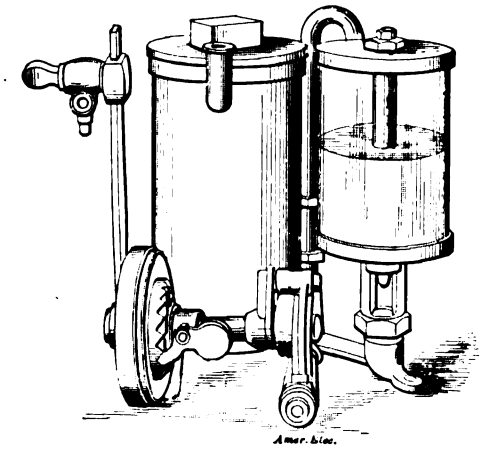


FIG. 8.—MILWAUKEE LUBRICATOR.

A type of lubricator is coming largely into use, in which the oil is made to drop from a sight-feed arrangement into a pump which forces into the cylinder whatever amount of oil may be delivered to it. Fig. 7 shows an arrangement of this kind, the oil dripping through the regulating valve at the top into the pump chamber, from whence it is driven into the oil pipe leading to the cylinder through the double set of check valves shown at the lower portion of the engraving. The glass around the sight feed is not under pressure. It is merely to keep out dirt and to keep in the oil when the pump fails to work, which is indicated by the filling up of the glass with oil.

It will be seen that the return stroke of the pump plunger must form a partial vacuum in its chamber. This serves to draw into the chamber any oil or grease, graphite or other lubricant which the device may be required to feed. A certain amount of the oil passes up alongside the plunger, lubricating it and the rack and pinion. To prevent the accumulation of too much lubricant in this part of the device, the return port is cut around the plunger into the suction chamber, so that any surplus oil is returned directly to the pump again. The device is made with one, two, three or four plungers, so that a single pump may serve an engine with several cylinders, and each cylinder may be given the exact amount of oil it requires, independent of the quantity fed to the other cylinders. This pump, although made to feed a special lubricant, will handle any kind. It is built by the Sight-Feed Oil Pump Company, Milwaukee, Wis.

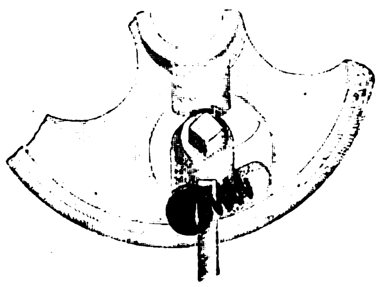
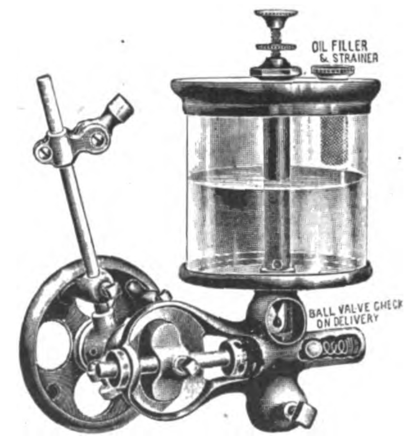


FIG. 10.



MANZEL LUBRICATOR.

Difficulty may be anticipated in feeding different kinds of oil through a sight-feed oiler into a pump so as to make a regular delivery of all kinds of lubricants. This is ingeniously taken care of in the Milwaukee force and sight-feed lubricator, shown by Fig. 8 and made by the Force-Feed Lubricating Company, Milwaukee, Wis. In this lubricator the larger chamber contains a loose, but well-fitting piston which has no connection whatever with any portion of the oil chamber or any other portion of the device. The shorter chamber contains a quantity of oil, equal in volume to the lubricant in the longer chamber. The oil drips past a regulating valve into the chamber of a plunger pump which is actuated by some convenient moving portion of the engine. As fast as the oil drips into the pump it is forced under the floating piston in the lubricant chamber. As this piston is forced up, it displaces an equal volume of lubricant which passes through a pipe to the steam pipe of the engine in the usual way.

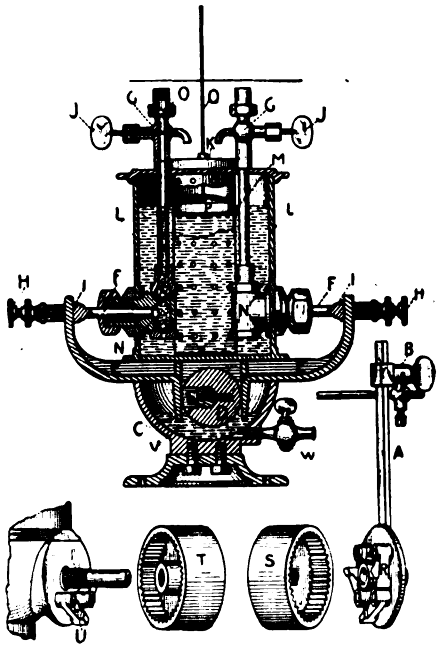


FIG. 11.—PHENIX LUBRICATOR.

When the sight-feed chamber is empty, it being the same in capacity as the lubricating chamber, that is empty also, and a by-pass valve is opened which allows the oil to flow back into the sight-feed chamber again by removing the plug in the top of the lubricant chamber, and then forcing the floating piston down to the bottom of its chamber. Then the by-pass may be closed and the chamber again filled with lubricant.

The neat form of sight and force-feed lubricator shown by Fig. 9 is made by Manzel Bros., Buffalo, N. Y., and designated the Manzel sight-feed automatic oil pump. It occupies very little space, and is adapted for use on very small engines, as well as very large ones. For this reason, it finds favor with automobile engine builders, and is adapted to gasoline, as well as steam engines. The method of operation is simple. An oscillating motion is given to the pump lever by means of a link from a convenient reciprocating part of the engine. Motion is imparted to the pump plunger by means of a ratchet mechanism of the ball wedge type, shown in Fig. 10. When the arm moves to the right the ball, pressed backward by a spring, wedges between a smooth wheel and the ratchet arm, locking them together and carrying the wheel in the desired direction. When motion is in the opposite direction, the spring behind the ball prevents the ball from locking the two parts together, therefore the wheel is not carried along on the back stroke of the ratchet lever.

There is a ball valve close to the pump plunger, and another ball check valve in the oil pipe as close as possible to the engine. The return stroke of the plunger produces a partial vacuum behind it, which draws in the oil as already described. The rate of delivery is indicated by the usual sight-feed glass, the oil being under no pressure except that of gravity. There is also a ball brake in the ratchet lever, which prevents the wheel from moving too far—about a quarter of an inch movement being found sufficient in most cases. The ball brake prevents a much greater motion of the wheel and a consequent too fast movement of the pump.

These lubricators are made with any number of pumps, from one to six, and the oil admission aperture is fitted with a filtering device to prevent clogging the pumps by dirt or other foreign matter in the oil.

Another force and sight-feed cylinder lubricator which finds favor among automobile people, is shown in cross-section by Fig. 11. This apparatus is made by the Phenix Metallic Packing Company, Chicago, and is known as the Phenix lubricating pump. It is not a sight-feed lubricator, yet the amount of oil passing at any instant through either of the pipes may be noted by simply turning the two-way cock so that the oil comes out of the drop spout instead of going into the cylinder. While the drop spout is open, the amount of oil passing is regulated by turning the adjusting screw, *H*, giving more or less lost motion to the plunger, *f*, and thereby regulating the amount of oil delivered per stroke of the pump. Motion is transmitted through a rod to the knuckle-joint, *B*, to the ratchet lever, *A*, and by means of the pawls and ratchets shown at *R*, *S*, *T* and *U*, operates the eccentric *D*, the link bar, *E*, and the pumps already described.

The lubricator can be filled without shutting off the supply to the cylinders, and steel ball check valves are furnished to withstand any pressure likely to be operated against. The eccentric, *D*, dips into a small amount of oil in the base of the pump. This oil is that which has found its way through the stuffing boxes on the pump plungers, and is thus made useful. A stem is shown at *Q*, which is attached to a float in the oil chamber, so that the quantity of oil in the lubricator may always be ascertained. This lubricator delivers oil at any distance, against high pressure steam, into a vacuum, or into a steam or a gasoline clyinder and is made to supply any number of cylinders from one to six.

SOME TELEPHONE WRINKLES.

BY J. W. STRIPPEL.

In party-line systems of telephones it often occurs that while a subscriber is talking over the line in one direction, for instance, east, some one on the west side would like to make a call on the unoccupied part of the line. This has been provided for by what are called extension bell switches, which enable a person to cut off that part of the line which he does not need, and also leave a bell connected in on that side in order to receive a call while that part of the line is cut off. In its normal position the switch will cut out the extension bell, cut in the telephone instruments and connect the line straight through.

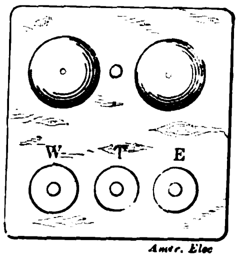


FIG. I.

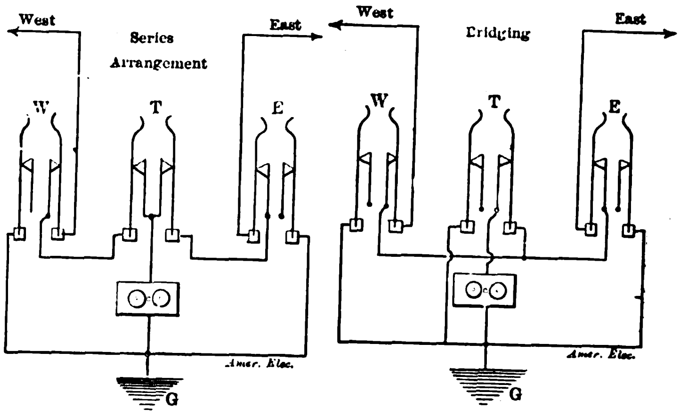


FIG. 3.—CONNECTIONS FOR GROUNDED CIRCUITS.

Any telephone man who has had any thing to do with the aggregation of levers and buttons (four levers and 12 buttons) called an "extension-bell switch," knows the difficulty of keeping the levers tight and the buttons clean. Very often the subscriber leaves the switch half way between the buttons, thereby opening the line, or in order to reduce the effort required to shift all four levers, he will lift them up, and by bending them accomplish the same purpose. Fig 1 herewith shows an arrangement which can be readily applied. Spare spring jacks and plugs are to be found in most telephone exchanges and, if necessary, can be bought for less than an extension switch would cost. Three spring jacks are mounted in a magneto box, and for the purpose of explanation are designated "east," "through" and "west" The plug is connected to the terminals of the telephone. By plugging in the jack called "east," the instrument is connected to the eastern part of the line and the extension bell connected with the western part. The line is now divided into two parts; anyone wishing to use the western end may do so without interference, or should they wish to call the station at which the switch (that is, plug and jack) was turned, they can do so by means of the extension bell. Similarly, by plugging in the "west" jack the 'phone is connected to the west side, and the extension bell to the east. Plugging in the "through" jack cuts the line straight through, puts in the telephone set and also takes the extension bell out of circuit.

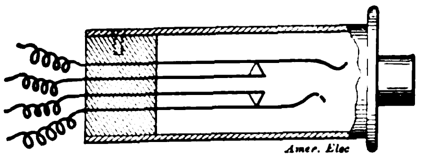


FIG. 2.—MULTIPLE JACK.

This arrangement is easily understood, simple to operate and less liable to open circuits and derangements than any other device. Even leaving the plug out entirely does not destroy the integrity of the line. Its simplicity and low cost justify its application to every party-line instrument. The diagrams show the connections for every class of party-line service.

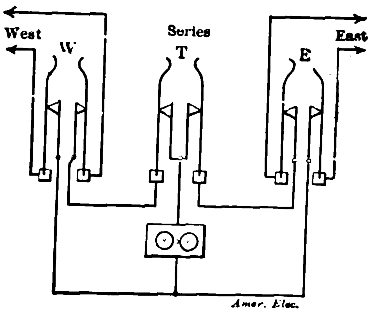


FIG. 4.—METALLIC SERIES CIRCUIT.

Most subscribers to a telephone exchange would like to have a telephone in their residence in addition to the one at their place of business, but do not think the additional advantage is justified even if a lower rental is charged. In many cases the residence is nearer to the store or factory than to the exchange, so that a short line can be run at a less cost between the residence and the store or factory. Fig. 6 shows a method of connect-

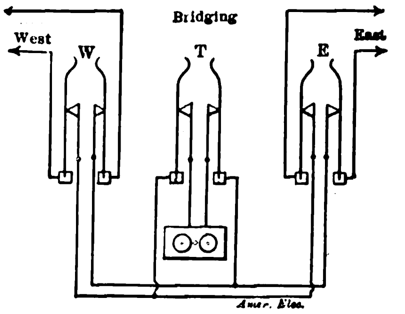


FIG. 5.—METALLIC BRIDGING CIRCUIT.

ing up such a line. The diagram is self-explanatory. The advantages of this arrangement are that the residence and office can call each other at all times without going through central. The residence can get central through the office by having the plug at the office pulled out entirely. This can also be done when the office is closed at the end of the day, leaving the line to central connected with the residence.

Lessons in Practical Electricity

DYNAMO FIELD MAGNETS AND MAGNET COILS.

While the horse-shoe shape of magnet shown in the previous Lessons, and used almost invariably in elementary discussions, is as simple as a magnet can be made. this form is not commonly used in the construction of modern dynamos. For a number of years it was the standard type, but has gradually been superseded by other forms which have magnetic and constructional advantages that more than compensate for the loss of simplicity. The horse-shoe type, which is repeated in Fig. 1, herewith, is still used, however, to some extent in small machines, but even in such machines it is more generally used inverted, as indicated in Fig. 2. The advantage of the inversion of the magnet is that an iron bed-plate can be used without provoking magnetic leakage. If the form shown by Fig. 1, be set on an iron bed-plate, even with blocks of wood in between, as indicated in Fig. 3, the magnetic leakage would be excessive; the dotted lines in Fig. 3 illustrate roughly this leakage.

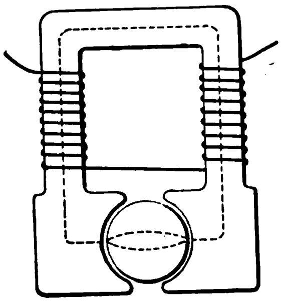


FIG. 1.

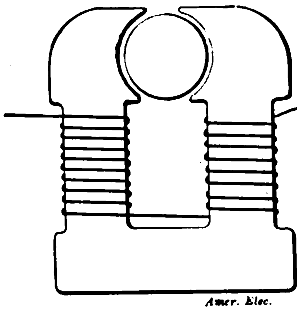


FIG. 2.

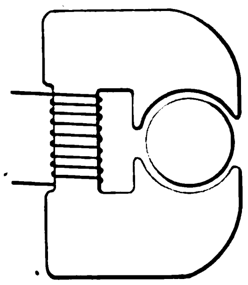


FIG. 7.

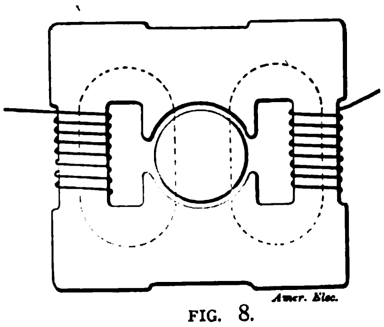


FIG. 8.

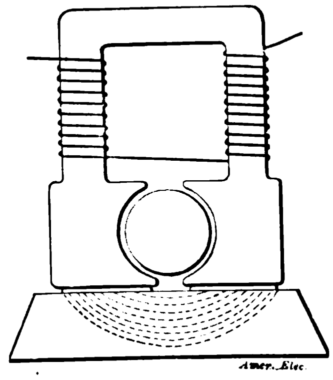


FIG. 3.

Fig. 4 shows another disposition of this type of magnet, which was used to a limited extent several years ago, but is no longer built in this country. It is open to the same disadvantage as the vertical type of Fig. 1, namely, an iron base-plate cannot be used without provoking leakage; in this case the leakage is from the pole-piece, *a*, across to the back end of the magnet core at *b*, thus shunting a large part of the magnetism away from the armature. Fig. 5 is precisely the same as Fig. 1 except that a single coil is wound on the horizontal portion of the field magnet instead of having two coils, one on each vertical limb. Fig. 6 bears exactly the same relation to Fig. 2, being simply an inversion of Fig. 5. Unlike Fig. 2, however, it is open to the objection that an iron base cannot be used without provoking excessive magnetic leakage.

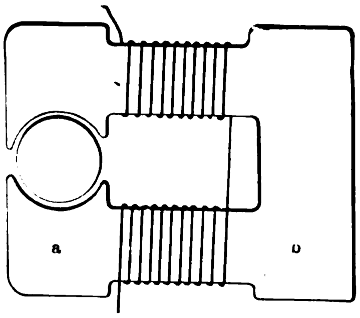


FIG. 4.

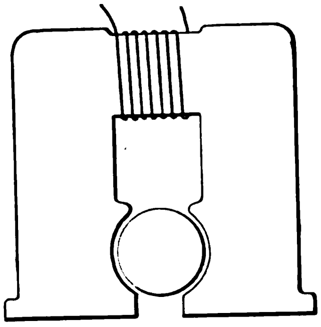


FIG. 5.

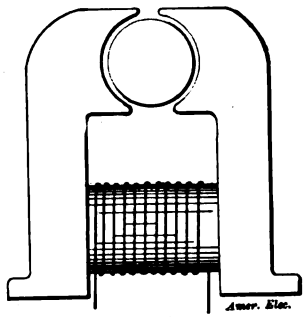


FIG. 6.

Fig. 7 is the single-coil equivalent of Fig. 4, and is the only single-coil bipolar magnet that can be mounted on an iron base. This form is used to some extent in very small motors, and the form shown in Fig. 6 is also used in a few small machines, the magnet in this case being mounted on a heavy hard-wood base. Fig. 8 shows a bipolar type which was in high favor in this country a few years ago, and is still used considerably in England. This is known as the Manchester type. It has the slight disadvantage of requiring considerably more wire in the magnetizing coils than the other types mentioned. In this machine there are two magnetic paths through the field magnet in parallel with each other, the magnetic flux through the armature separating at each pole-piece into two parts, one half passing to the left and the other to the right. Such a machine, as compared with Fig. 7, of which it is merely an elaboration, would require only one-half the cross-section in each magnet limb that the machine in Fig. 7 requires in its single magnet limb. This, of course, would make the diameter of the field magnet coils smaller, but, on the other hand, the densities being the same in the two machines, each of the coils in Fig. 8 would require the same number of ampere-turns that the single coil in Fig. 7 requires, the ampere-turns of a magnet being proportional to the flux density in the path and not to the total amount of flux.

All of the field magnets thus far mentioned are of the "open" type. A much better type of bipolar field magnet is that shown by Fig. 9, which is known as the Continental type. The difference between this form and that of Fig. 8 lies chiefly in the arrangement of the magnet coils, the coils in Fig. 9 being placed directly on the poles, while in Fig. 8 they are placed on the portions connecting the two poles. This difference, however, has the effect of transforming the machine from an open to an "iron-clad" one, in which the magnet coils are entirely protected from mechanical injury, and a smaller amount of wire is required. This form of magnet was used by many of the smaller manufacturers up to a few years ago, when the advantages of multipolar field magnets became better known and adopted exclusively for larger machines. The circular form of magnet

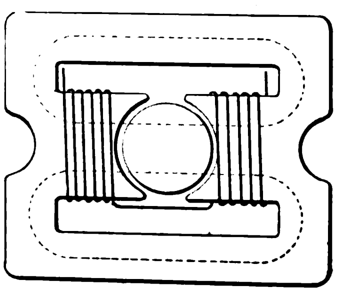


FIG. 9.

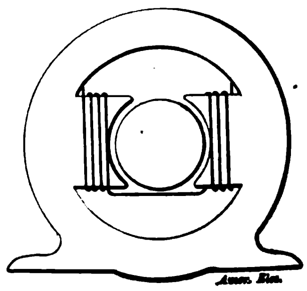


FIG. 10.

frame used with these machines was then applied to the small bipolar machines, with the result shown by Fig. 10, which will be recognized as being precisely equivalent to Fig. 9, the only difference being in the shape of the two frames. Like the Manchester type of Fig. 8, the magnet circuit in Figs. 9 and 10 divides into two parts outside of the magnet poles proper, one-half of the flux passing through one-half of the yoke, and the other half through the other half of the yoke.

As just stated, machines of appreciable size are now built with more than two poles, the form of magnet most generally used being that illustrated by Fig. 11, which shows a four-pole machine with the circular yoke mentioned above. The paths of the magnetic flux through each field circuit and the armature are incidated by the dotted lines, which show that there are four distinct circuits in the machine. In such a machine each magnet-coil supplies each pair of magnet circuits through its core from a point in the yoke-ring midway between two poles to a point in the armature midway between the same poles, these points being indicated in the engraving by x and y. That is to say, each coil creates all of the flux which passes through the pole surrounded by the coil and drives this flux through the two paths in parallel in the yoke and armature up to the point indicated by x and y, the neighboring coil taking care of the remainder of the path from those points through its own core.

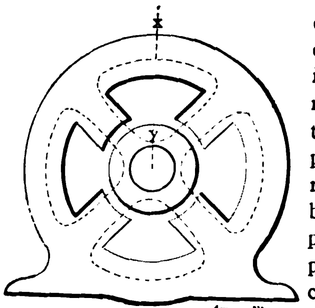


FIG. 11.

Other forms of multipolar field magnets are in use, but this is the recognized standard of modern practice and is used for machines having large numbers of poles.

The advantages of multipolar field magnets over the bipolar type are (1) a simpler armature winding and one more accessible for repairs, as will be explained in a future Lesson; (2) a smaller amount of material due to the sub-division of the magnetic flux—this is illustrated plainly by Fig. 12, which shows a bipolar, a four-pole and an eight-pole machine, all having the same total flux through the armature; (3) a greater ability to dissipate heat on account of the greater area of surface per unit of volume in each magnet pole and winding, and also in the armature.

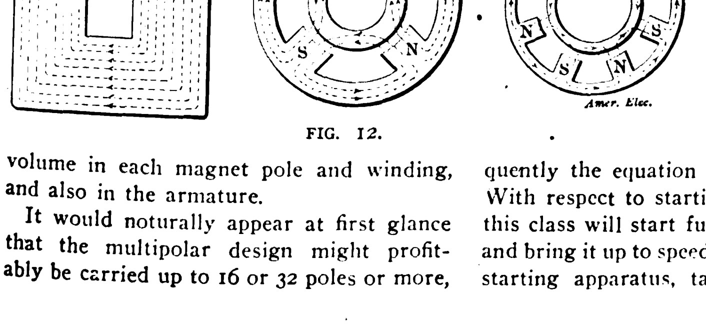


FIG. 12.

It would noturally appear at first glance that the multipolar design might profitably be carried up to 16 or 32 poles or more, but this is not true except for huge machines. Machines of moderate size are most economically built with four poles; making the number greater than this increases the expense of winding coils, machine work and other fittings, out of proportion to the gain in material.

Letters on Practical Subjects

Light Effects on a Rainy Night.

To the Editor, American Electrician:—

The following color effects observed by the writer on a rainy night recently may be of interest to the readers of the AMERICAN ELECTRICIAN. Street arc lights under entirely normal operation showed a deep violet color at the arc; 118-volt incandescent lamps showed a brilliant yellow; Welsbach gas lamps were distinctly green; a common gas street lamp showed a yellow hue faintly tinged with dirty red, and Kitson oil lamps showed a greenish white flame. All lamps surrounded by colored glass showed the true color of the glass, but about a shade darker.

CHAS. STEINBERG.

New York City.

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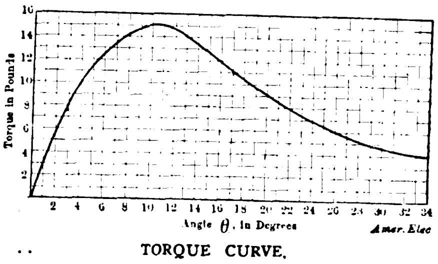
Induction Motors With Commutator Start.

To the Editor, American Electrician:—

In the article entitled "The Single-Phase Induction Motor" in the June number of the AMERICAN ELECTRICIAN, by Mr. McAllister, the discussion of the action of an induction motor starting with commutator and brushes is not in accordance with the actual facts. I send you herewith a curve showing the relation between the angle θ, Fig. 7, page 252, and the starting torque taken from a two-pole 25-cycle motor. The maximum torque is reached when θ is 10 degrees in this case. At 34 degrees the torque has dropped to full-load torque and for points beyond would be correspondingly less. The effect of the reactions of the armature currents on the field has been neglected entirely. In the case of an induction motor, where the armature is completely surrounded by iron, the reactions will have a greater effect on the motor than on a motor with pole-pieces, as shown in Fig 7. If the motor has no pole-pieces, but a slotted field completely enclosing the armature, as is the case with induction motors, a current through the armature will tend to set up a field in the direction of the brushes. The field coils will tend to set up a field in the direction of the field winding, the actual field being the resultant of the two and not in the direction of the field winding; consequently the equation given does not apply. With respect to starting current, motors of this class will start full load from standstill and bring it up to speed without any external starting apparatus, taking about two and one-half times full-load current on first closing the switch, rapidly decreasing to full load current when running speed is reached and the armature automatically short-circuited. By the use of a small auto-transformer with several steps, the motor can be brought up to speed under full load with full-load current. In each case the starting torque per ampere is greater than the running torque per ampere. If the commutator and brushes are properly designed for this work, there is no need of commutator troubles, and an experience of several years with a large number of motors of this class ranging from ¼ to 30 horse-power, has shown that they are less liable to commutator trouble than direct-current motors.



TORQUE CURVE.

EDW. BRETCH.

St. Louis, Mo.

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Three-Phase Transformer Operation.

To the Editor, American Electrician:—

I should like very much to have some reader of the AMERICAN ELECTRICIAN explain the following performance to me. I am working on a large transmission plant, having a main line 87 miles long with five sub-stations. The transformers in the main station are connected delta on the station side and Y on the line side, and raise the voltage from 750 to 33,000. The transformers in the sub-stations are connected similarly; that is, Y on the line side and delta on the station side. At one of the sub-stations, which we will call *A*, there are three 200-kw. transformers of standard make, which supply a branch line to a sub-station, *B*, in a town 28 miles away, where there are three similar transformers connected Y to delta. A stroke of lightning burned out one of the transformers at *A*, causing a shut-down, and as a sort of desperate venture, the operator at this station cut out the damaged transformer, and without changing any of the connections to the line, plugged the circuit through to the second sub-station, *B*. Much to everybody's surprise, the latter sub-station received the customary voltage all around, except that one leg was two volts high. The neutrals of all the Y-connected windings are grounded with a ground ammeter in series at the main station; this ammeter did not show any ground current. The question is, how did the transformers work? It is well known, of course, that when three transformers are connected up in delta, one of them may be cut out and the other two will continue working without trouble, but in this case one side of each set of transformers was connected in delta and the other side in Y.

B. F. PEARSON.

Redlands, Cal.

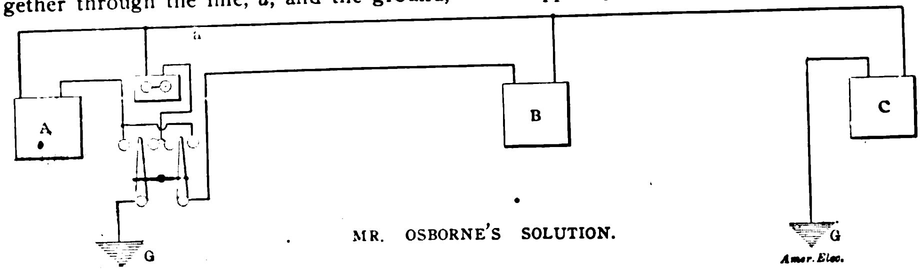
Mr. Chase's Telephone Problem.

To the Editor, American Electrician:—

Referring to Mr. Chase's solution of his telephone problem, which was published in your last issue, it appears to me that this method is open to the objection that if Station A is talking with Station C, Station B is unable to call up Station A. The method of connections shown by the accompanying diagram gives a convenient solution of the problem. In this arrangement there is required only an auxiliary bell and a double-pole, double-throw switch at Station A. By throwing the switch to the left Station A and Station C are connected together through the line, *a*, and the ground, and Station B has a closed circuit through the auxiliary bell. Throwing the switch to the other side puts Station A and Station B together on metallic circuit and connects Station C through the auxiliary bell to the ground. Consequently, no matter which way the switch lies, the station to which the telephone at A is not connected can call up, while the other station can call up in the usual manner. This arrangement might be modified to allow all three stations to talk together by inserting a single-pole switch in the wire leading from the line, *a*, to the auxiliary bell, and arranging the double-pole switch so that it can touch all of the contacts at the same time when in the mid-position. This plan is somewhat similar to that suggested by Mr. Gobel in the June number, but has the advantage of greater simplicity in connections.

H. G. Osborne.

Brooklyn, N. Y.



MR. OSBORNE'S SOLUTION.

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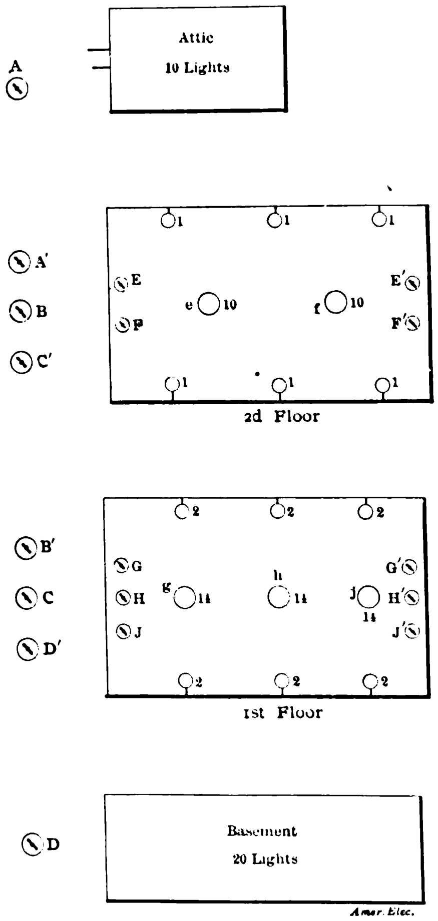
A Problem in Electric Light Switch Connections.

To the Editor, American Electrician:—

The accompanying diagram shows an arrangement of outlets and switches which are to be wired up in the following fashion. The switches *A* and *A'* are to control the attic lights independently; the switches, *B* and *B'*, are to control all the lights on the second floor independently of each other; the switches, *C* and *C'*, are to control the lights on the first floor, and the switches, *D* and *D'*, to control the lights in the basement. The switches *E* and *E'*, on the second floor, control the fixture, *e*, independently from both ends of the hall, and the switches, *F* and *F'*, control the fixture, *f*, independently. On the first floor the switches, *G*, *H* and *J*, control the outlets, *g*, *h* and *j*, and the switches, *G'*, *H'* and *J'*, control the same outlets independently. The problem is to wire up the outlets and switches with the least number of wires, and at the same time conform to the Undewriters' rules. This number of lights to each outlet is marked on the diagram. The mains enter in the basement and the brackets on both the first and second floors are turned on and off by a socket key.

E. W. D. Cummings.

Sydney, C. B.



PROBLEM IN CONNECTIONS.

Electrical Catechism

700. What solution is used in depositing a brass coating?

Dissolve 2 ounces of carbonate of zinc and 4 ounces of cyanide of potassium in water. Add this, little by little, to part of the copper cyanide solution described in No. 683, the effect being noted on a test piece which is being plated in the bath. By varying the amount of the zinc solution and adjusting the current, brass of any desired color may be deposited. A little carbonate of ammonia will make it a light yellow. A strong current will deposit more zinc than copper, and will make the brass paler; a weaker current will deposit more copper than zinc, and will make the brass deposit redder. For depositing a brass coating the anodes should be of brass, or may be alternate copper and zinc plates.

701. What solution is used in nickel plating?

The double sulphate of nickel and ammonium is generally used. From 12 to 16 ounces of this is dissolved in a gallon of pure boiling water in a clean wooden vessel; after cooling, water is added until the solution has a density of about 1.03 to 1.06. The solution should be about neutral or slightly acid, and can be tested by litmus paper turning red when wetted if the solution is acid or turning blue if it is alkaline. It is generally necessary to add a little ammonia from time to time while the bath is in use. From 3.5 to 6 volts are necessary for nickel plating, and the current should be from 0.3 to 0.65 amperes per square foot of plated surface. The number and size of the anodes will vary with the amount and character of the work; they should always reach down as far as the bottom of the work, and should have somewhat larger surface. Since the solution is denser near the bottom of the bath, it deposits faster than near the top, and therefore long articles should be hung horizontally and should be turned half-way around when the plating is about half done, in order to make the coating of uniform thickness.

702. What solutions are used in silver plating?

The solution in general use is the double cyanide of silver and potassium. The simplest way of making it is to dissolve 2 ounces of cyanide of silver in water; in another vessel dissolve 4½ ounces of cyanide of potassium in water; mix and stir thoroughly; add water to bring the whole to 1 gallon, and filter through closely woven muslin or calico. When plating is done on a large scale, it is common to make the solution from the chloride or nitrate of silver, which is changed into the cyanide of silver by more or less prolonged processes, for which one should refer to the special handbooks. The anodes should be of pure silver, not of coin metal or plated ware, and should have a surface about equal to that of the work. About one volt will send sufficient current through the cell. The current should be about one ampere to 60 square inches of work. Care should be taken that everything is scrupulously clean, and that the anodes and solution are pure. The work is generally kept moving slowly back and forth in the solution in order to make the deposit uniform.

703. What solutions are used in gold plating?

The double cyanide of gold and potassium is generally used. This is prepared from metallic gold dissolved in a mixture of nitric and hydrochloric acids, which are then evaporated, leaving crystals of chloride of gold. After repeated washing and evaporation, the chloride is dissolved in water to which is added a solution of cyanide of potassium. This forms a yellow precipitate of cyanide of gold; this is washed and then dissolved in a solution of cyanide of potassium, forming the double cyanide of gold and potassium. The operation is tedious and requires much care, besides being expensive. The experimenter should study a good handbook before attempting to plate gold.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Why is a reactance coil put between transformers and a rotary on the high-voltage side of a circuit? W. C. H.

To adjust the voltage of the machine.

What size of wire should be used to wind the ¼-h.p. single-phase motor described in "Electrical Designs" for 50 volts and 140 cycles? L. A. H.

Use three turns of No. 10 per slot, instead of twelve No. 16 wires per slot.

How can the small storage cell described on page 84 of the American Electrician for February, 1902, be formed and charged from a 110-volt circuit? (2) What are form-wound armature coils? W. T. A. F.

By connecting it in series with a group of eight or ten 110-volt 32-c.p. lamps, the lamps being connected in parallel with each other. (2) Coils that are wound to shape on a former and insulated before being put on the armature core. The other kind of armature coil is wound directly on the core.

How can I double the number of coils in a 30-h.p. wave-wound armature having 51 slots and 51 coils? The present coils lay in slots 1 and 14 and are connected to commutator segments 1 and 27. A. G.

Make 102 coils of the same size of wire, using one-half the present number of turns per coil. Put the coils in the slots as they now are except that two coils will take the place of each one of the old coils. Cut the terminals of one coil off close up to the coil and tape the ends thoroughly. Leave this coil dead, use it merely for mechanical balance. Use a commutator with 101 segments and connect the terminals of each coil 50 segments apart; that is, calling one segment No. 1, the segment to which the other end of a given coil is connected will be No. 51.

Does a lap-wound armature have to be cross-connected? (2) Should four-pole and six-pole wave-wound armatures have an odd or an even number of commutator segments? (3) Should a two-pole armature have an odd or even number of coils? (4) Why will a commutator insulated with three layers of shellacked canvas at the ends show a ground when the shellac is green? The same magneto will not ring through ¼ in. of the same shellac in a jar. A. F.

Not unless the machine is multipolar and has only two sets of brushes. (2) A four-pole wave-wound armature must have an odd number of commutator segments; a six-pole machine can have either an odd or an even number. (3) A two-pole armature can have either an even or an odd number of coils, but an even number is usually preferable. (4) Because the resistance through the shellacked canvas is less than that of ¼ in of fluid shellac.

How can I run a small fan motor on a 220-volt light circuit; that is made to run on four cells of battery? O. M.

Connect it in series with a 220-volt lamp. If this does not give you sufficient speed, put two 220-volt lamps in parallel with each other and connect the motor in series with them.

Please give me directions for making a dry battery. (2) Can the number of lines of force passing from pole to pole of a permanent magnet be calculated? (3) Does electricity at high tension travel any faster than electricity at low tension? W. G. G.

Full instructions are given in "Electrical Designs," the price of which is $2. See also answer to J. B. N in this issue. (2) No. (3) No.

How many 32-c. p. 110-volt lamps should be used to replace a 40-ohm resistance, the circuit passing 7 amperes? (2) What should be the insulation resistance of a 110-volt circuit? H. S. S.

You cannot obtain exactly 40 ohms resistance with 32-c.p. lamps. The resistance of one lamp is about 110 ohms, so that two lamps in parallel would give you about 55 ohms, and three lamps in parallel will give you 37 ohms, which is as near as you could come to 40 ohms. Three lamps in parallel, however, will not stand 7 amperes. (2) Not less than a megohm.

What determines the thickness and width of a dynamo yoke ring. (2) What is an electrodynamometer. (3) What is a reactance coil? J. B. S.

The cross-section of a yoke ring is determined by the amount of magnetic flux that it has to carry. The question of whether the ring should be made wide and thin or narrow and thick is purely a mechanical one. It should not be so thin as to be mechanically weak, and it should be amply wide to entirely cover the coils on the magnet cores. (2) An instrument for measuring current or power. See the description in the American Electrician for May, 1901. (3) A coil of low resistance and highly self-inductive. In order to obtain this combination the coil is almost invariably wound upon a closed iron core.

Do pipe lines using superheated steam require to be of as great a diameter for the same power as those for saturated steam? J. H. K.

No. One advantage of the use of superheated steam over saturated steam is that it flows through a pipe line at the rate of about 100 feet per second with the same drop in pressure as saturated steam requires to flow sixty feet per second. Consequently, pipe lines carrying superheated steam do not require to be so large as those carrying saturated steam for the same power. The difference in diameter is of course, in favor of superheated steam, as radiation is thereby lessened. It should be added, however, that great pains must be taken with the insulation of superheated steam-pipes lest they lose a substantial degree of superheat before the engine is reached. While less heat units will be radiated from a superheated steam-pipe for the same area, the drop in sensible temperature, as measured by a thermometer, is much more marked.

Kindly give directions for making a dry cell. J. B. N.

Make a zinc cup, and fit snugly inside the cup a tube of blotting paper having three or four turns. Pour into the bottom of the cup about two tablespoonfuls of hot melted pitch or rosin, to insulate the bottom. Dissolve 5 ozs. of sal ammoniac in one pint of clear water and add about 7 ozs. of granulated chloride of zinc. Stir until dissolved and continue stirring every few minutes for one-half hour or more. The solution is then ready for use. Soak the blotting paper inside the cup thoroughly with the solution by filling the cup about three-quarters full and letting it stand for a few minutes. Pour out the solution and place a carbon plate in the center of the cup; about it pack a depolarizing mixture of 8 ozs. of powdered black oxide of manganese and 16 ozs. of powdered carbon which has been previously moistened with about 5 ozs. of the solution. The packing will probably force a little of the solution up the paper by compression, but that will not injure the cell any. When the powdered elements are wet enough, clean away all particles of the carbon element from the top of the paper and the zinc cup so that there will be no internal short circuit. The cup is then sealed with pitch or rosin and when connections have been made to the zinc and carbon, the cell is ready for use.

What is the difference between power and work? (2) What is the electrical unit of work? (3) What is the electrical unit of power? (4) What is the principal advantage of the rotary field type of alternating current motor over the synchronous type? (5) What do you understand by a rotating field? C. M.

"Work" is what is accomplished by the expenditure of energy, and "power" is the rate at which this energy is expended. For example, if a pile of 100 bricks were removed from one floor of a building to another floor ten feet above it, and the bricks weighed one pound each, carrying each brick from one floor to the other would represent an expenditure of ten foot-pounds of energy, so that when the entire pile was transferred 1000 foot-pounds of energy would have been expended. If the work of doing this consumed two hours, the power or rate of working would have been 500 foot-pounds per hour. (2) There is no practical electrical unit of work, but electrical work is usually referred to as watt-hours or kilowatt hours, as the case may be, a kilowatt being 1000 watts. (3) The electrical unit of power is the watt. (4) The principal advantage of the induction motor over the synchronous machine is that it can be started up under load more readily. Another advantage is that it requires no source of direct current to excite the field, whereas a synchronous machine does require such a source. (5) A rotating field is a magnetic field which rotates about the axis of a machine, which is the center of the magnetic system.

MONARCH AUTOMATIC ENGINE-STOP AND SPEED LIMITING DEVICE.

Not infrequently in the operation of steam-driven plants do emergencies arise where the shutting off of power is of paramount importance, but it often happens that at these critical moments the engineer is not at the throttle. To provide a means for automatically stopping the engine from any part of a building by the mere pressing of a button is the office of the engine-stop. The accompanying illustrations show a system of this character for use in connection with steam or electric machines, which is known as the Monarch system and is controlled by the Consolidated Engine-Stop Company, of New York. Fig. 1 shows the stop with the cover lifted, and Fig. 2 is a vertical section of the apparatus, illustrating the complete mechanism and its operation.

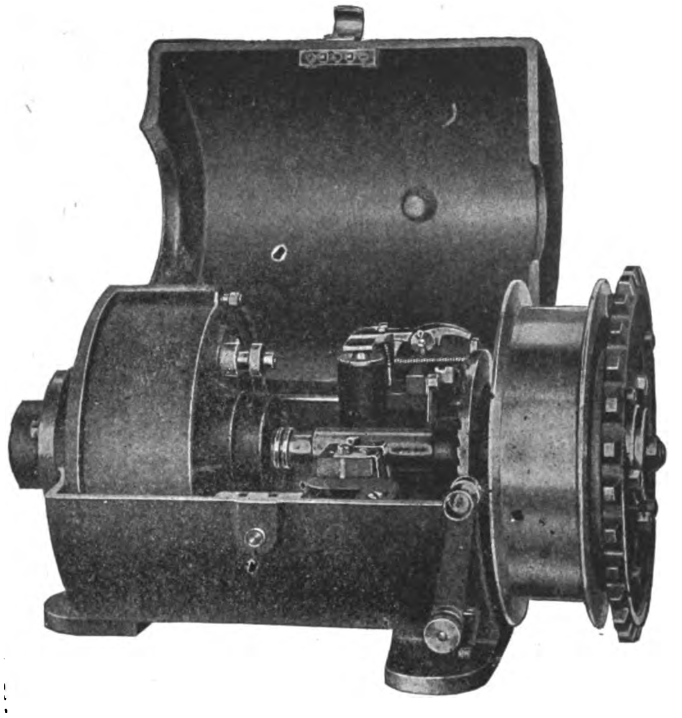


FIG. 1.—MONARCH ENGINE STOP.

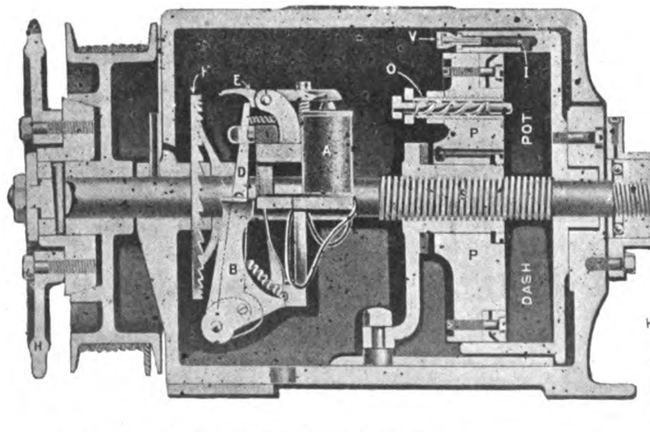


FIG. 2.—CROSS SECTION OF THE MONARCH ENGINE STOP.

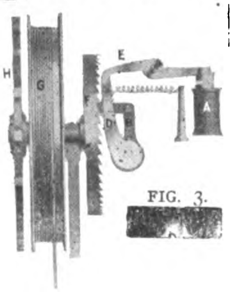


FIG. 3.

The mechanism is enclosed in a cylindrical iron case, the upper half opening on hinges, as shown by Fig. 1. Passing through this shell and turning on ball bearings is a steel shaft 1½ inches in diameter, on the outer end of which is attached a drum to which is bolted a sprocket wheel, *H*, shown in Fig. 3. Around this drum passes a wire cable, *G*, to which is attached a weight which serves to operate the stop. Inside the case and fastened to the shaft is a ratchet wheel, *F*, engaged by a pawl, *B*, which prevents the weight from turning the shaft in the direction that closes the valve. This pawl is held in engagement with the ratchet by a vertical lever, D, which is held in position by the left-hand end of the armature lever, *E*.

The magnets, *A*, are in circuit with an electric battery, and when the circuit is closed by pressing a button the armature end of the lever, E, is pulled down, releasing the upper end of the vertical lever, *D*, which also serves as a hammer and strikes a lug on the pawl, *B*, throwing the latter out of engagement with the ratchet and allowing the shaft of the stop to revolve and close the valve by means of the sprocket chain attached to the sprocket wheel of the stop and engaging a similar sprocket wheel attached to the trottle valve stem.

At the opposite or right hand end of the stop is a dash-pot, as shown by Fig. 2, into the cylinder of which the piston, *P*, fits closely. On this end of the shaft is cut a square-thread screw, *S*, passing through a nut in the center of the piston, *P*, so that as the shaft revolves the piston is carried, by means of this screw, into the cylinder and the air behind its inner face is compressed, thereby forming a cushion.

The speed at which the stop acts may be adjusted by turning the by-pass valve, *V*, that governs the amount of air that is forced through the air passage, I, as the piston moves in. Below this by-pass valve and in the piston is located the releasing valve, *O*. This valve is opened by contract against the bottom of the dash-pot and is adjustable. After the piston has cushioned and the throttle valve of the engine is near its seat, the compressed air in the chamber, *I*, escapes through the releasing valve, *O*, permitting the throttle valve to take its seat softly, yet with sufficient force to close it tightly. The safety stop is made for vertical and horizontal equipments. Its action is very rapid, the throttle valve being closed, it is said, in from three to ten seconds after the button has been pushed.

Fig 4. shows a speed-limiting device used in connection with the safety stop for automatically preventing excessive speed by the engine. The machine consists of a pair of governor springs arranged on a horizontal shaft and provided with the usual central balls. When the speed increases beyond the desired point, the balls, separating by centrifugal force, move a sliding collar on the shaft, to which they are connected, until this collar comes in contact with two electrical terminals, thus completing the circuit and putting the engine-stop in operation. The terminals can be adjusted so that the circuit is not closed until the engine reaches the desired speed. The shaft of the device runs in ball bearings and is driven by a belt from the main shaft of the engine.

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NEW WATER-WHEEL GOVERNOR.

Some of the principal troubles found with water wheel governors are their tendency to race or hunt on the slightest provocation, lack of sensitiveness and accuracy, and lack of co-operation with the fly-wheel effects of the plant. With the ordinary ball governor in an increase in speed, the governor has a tendency to pinch or bind at the joints at the ends of the ball arms, and the balls cannot alter their position until the speed has varied sufficiently to overcome the friction at these points. In the governor made by the Replogle Governor Works, of Akron, Ohio, this tendency is said to be entirely overcome by introducing an inertia will operate and place the governor in action before the balls themselves can wheel in the governor and suspending it from the balls by a flexible chain. If the speed should decrease, the inertia wheel

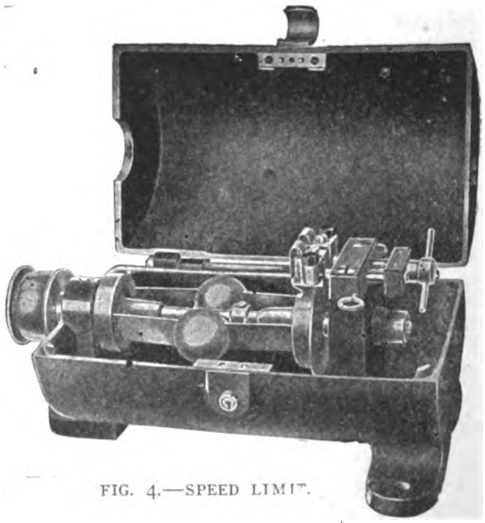
FIG. 4.—SPEED LIMIT.

overcome the friction at these points and drop. The opposite is said to be true also in the case of an increase in speed. The governor is said to be peculiarly adapted for governing turbines having long closed flumes to admit the water, since with a very slight change in speed the gate movement is scarcely perceptible, but with very heavy change the gate movement is very rapid. This gives the water column some time to get into motion, and in itself tends to check the tendency to racing. A close examination of the illustration will reveal a sphere between two concave discs, only one of which is visible. The internal surface of the discs is of leather, in order to provide the necessary friction to communicate their motion to the sphere. The discs, however, are machined on a somewhat larger radius than that of the sphere, so that when the sphere stands centrally between the discs only the centers of the discs touch the sphere. These centers are of lignum vitae and of course communicate no motion to the sphere. The discs are in constant motion, revolving in opposite directions, and the sphere is keyed fast to a hand-wheel shaft, which is geared to a wheel-gate shaft. The hand-wheel shaft may be moved in a longitudinal direction for a distance of about ¾ in. either side of the center line of the discs. Springs at the outer ends of the disc shafts secure frictional contact between the discs and the sphere. By the rise and fall of the weights and lever attached to the speed governor, the governor mechanism is brought into action and pushes the sphere away from the center line of the discs. If the change in speed is slight, the longitudinal movement of the sphere will be slight and cause contact with the discs at a point about 1½ inches from their centers, communicating a slow speed to the sphere and causing a correspondingly slow motion of the gate. If the change in speed is greater the movement of the sphere away from the center of the discs is correspondingly greater, giving a greater speed to the sphere and faster gate motion. Extreme changes in speed cause the sphere to come in contact with the discs near their outer edges and correspondingly rapid gate motion will result. The springs at the ends of the concave friction shafts communicate their pressure to the discs by means of a polished steel ball inserted in the end of the shaft, the spring pressing on a steel lug attached on the ball, thus giving practically a point bearing. The bearing is lubricated by means of heavy oil supplied at intervals of two or three weeks. The governor is provided with ring oiling bearings, gauge glasses, cut gears, etc., and is known as the "Differential" water wheel governor from the method of operating the gate.

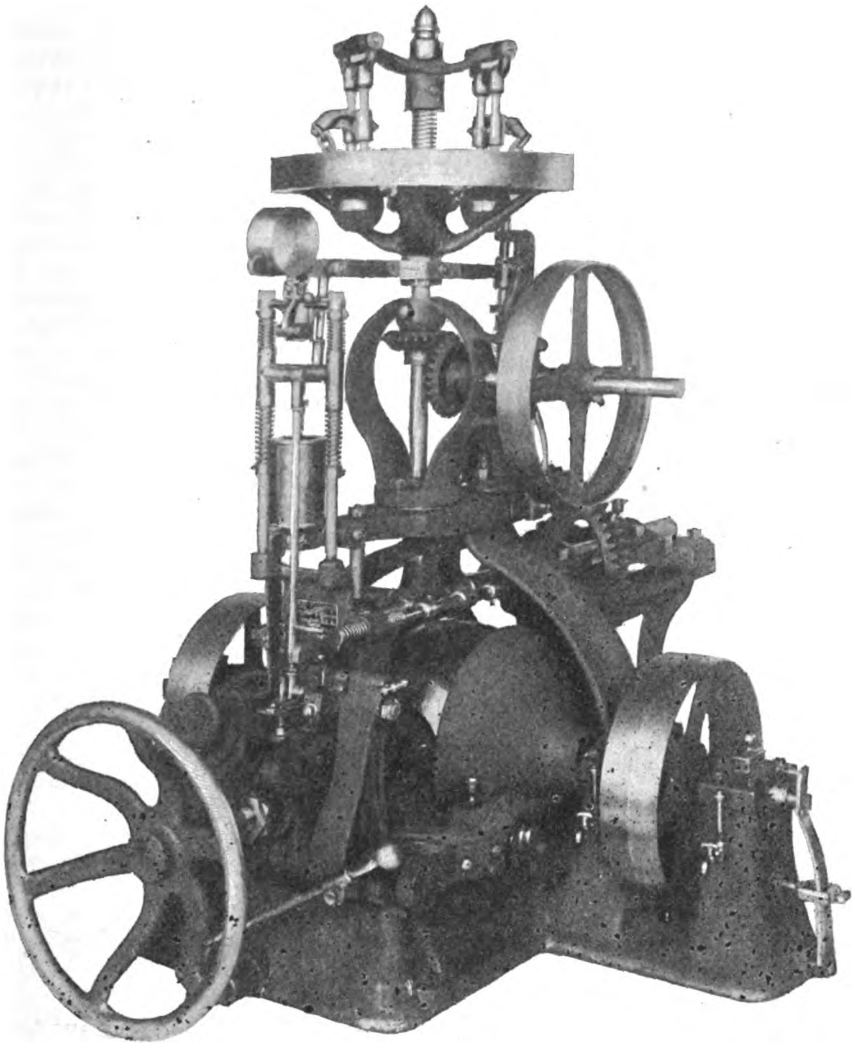
FIG. 1.—REPLOGLE DIFFERENTIAL WATER WHEEL GOVERNOR.

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DOUBLE GENERATING SET.

In the accompanying engraving (Fig. 1) is shown a generating set, comprising a Buffalo forge horizontal center crank engine and two direct-connected generators. The two generators and engine are bolted to the same cast-iron sub-base, the engine bed being near the center of the sub-base, and the field frames of the dynamos on either side. The two ends of the shaft are carried in out-board bearings, which are likewise secured to the sub-base. The main shaft carries the two armatures and the large governor wheel as well. The cylinders of this engine are provided with an efficient dead-air insulating space, and a polished sheet-metal covering. The piston is made remarkably firm and light. The crank shaft is a single forging of open-hearth steel, to which the counter-balancing discs are so fastened as to reduce the vibrating and shaking forces to a minimum. The connecting rod is of forged steel, and has a cross-head provided with a bronze box, which may be adjusted by means of a wedge and two screws. The crank end is of the locomotive strap type, with a wedge adjustment, and the boxes are lined with babbitt metal. The valve motion is obtained from an eccentric which is controlled by a shaft governor. This governor is especially adapted to the great regularity of speed required for electric lighting service. It is light and effective, and possesses two means of adjustment. The lubrication has been most carefully considered. The crank disc and connecting rod are enclosed and run in oil, while the wrist-pin bearing is provided with a cup which is supplied with oil from the same source. The out-board bearings are of the standard Buffalo adjustable type, ring-oiling and self-aligning. The entire oiling system of this engine is said to be efficient and economical of lubricant. The engine is constructed by the Buffalo Forge Company, of Buffalo, N. Y.

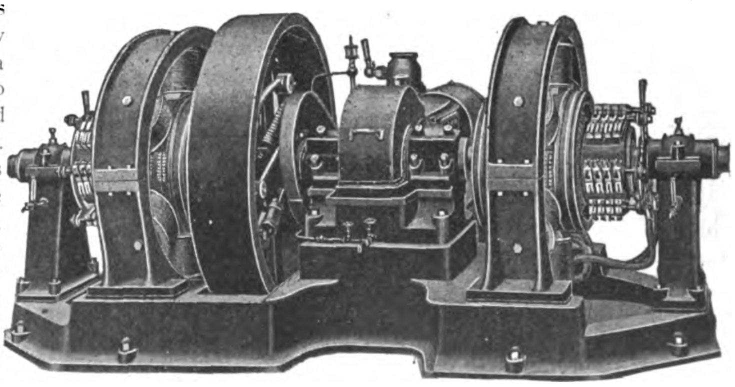


FIG. 1.—DOUBLE GENERATING SET.

New Apparatus and Appliances

UNIVERSAL RADIAL DRILL.

The accompanying engraving illustrates the latest full universal radial drill brought out by The American Tool Works Company of Cincinnati. The element of strength has played an important part in the design and construction of these machines, and with that end in view the column has been made unusually large and is firmly supported by an inside stationary stump extending its entire height with a bearing on the top, affording exceptional stiffness and rigidity. The arm is of new and original design. It permits of all lower driving gears being brought direct to the central driving shafts through the medium of bevel gears mounted on a vertical shaft and enclosed in the arm. It is raised and lowered rapidly by a double thread coarse pitch screw running in a bronze nut directly on the load line, reducing friction to a minimum. The head is universal in its action and is clamped in any position instantly by means of fixed binders at the top. Movement along the arm is controlled by a hand wheel through rack and multiple gearing. The spindle has three changes of feed and sixteen changes of speed. The back gears are located on the arm, and can be thrown in or out while the spindle is in motion by a convenient lever. Correct vertical position is determined by a dowel-pin in the head, which insures accuracy of alignment with the platen. The tapping attachment shown in the illustration is invaluable where a great amount of tapping is to be done. By means of a patented friction located in the arm the tap can be advanced to its required depth, and the lever thrown instantly without the operator leaving his position. The spindle may be reversed and the tap backed out at accelerated speed by throwing from gears-in to gears-out. Motion of the spindle can be stopped instantly either by the lever controlling the back gear or lever controlling the friction, thus obviating all necessity of stopping the entire machine through the countershaft.

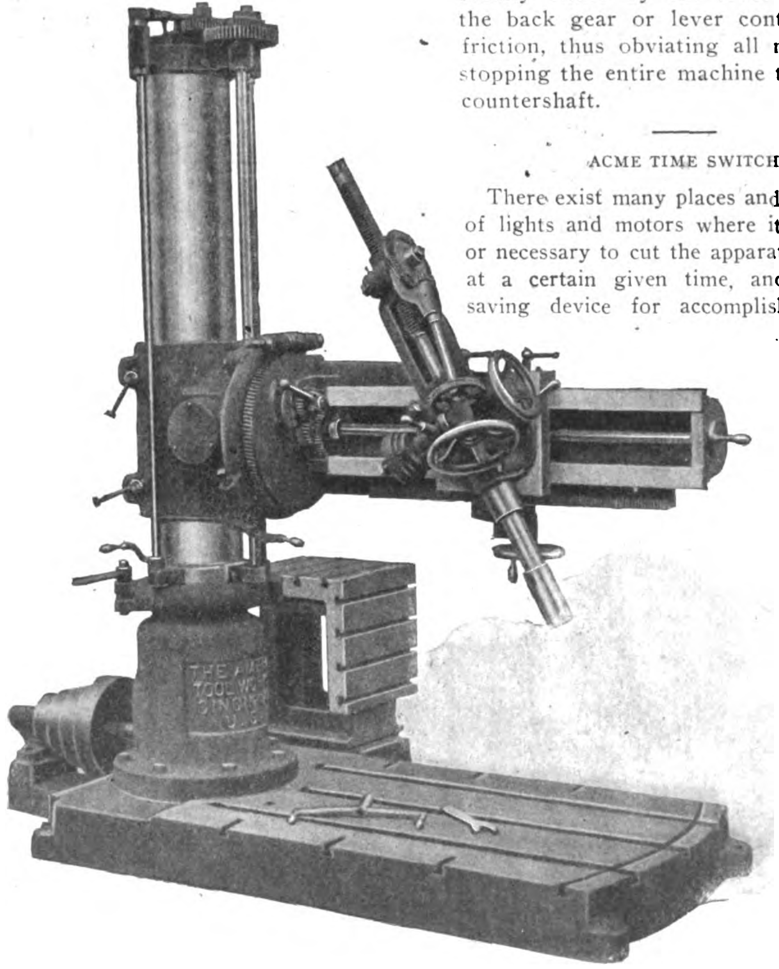


FIG. 1.—UNIVERSAL RADIAL DRILL.

ACME TIME SWITCH.

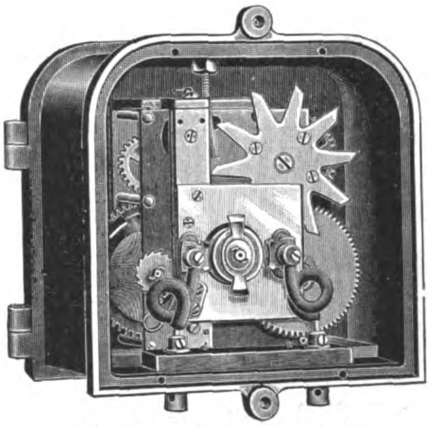


FIG. 2.—ACME TIME SWITCH.

There exist many places and installations of lights and motors where it is desirable or necessary to cut the apparatus in or out at a certain given time, and the labor-saving device for accomplishing this is termed a time switch. Many forms of this useful piece of apparatus are on the market, and have been described in these columns from time to time. One of the latest forms of time switch brought out by the Acme Switch Company, of Hartford, Conn., is shown by Fig. 2 herewith. It is of the single-pole rotary form designed for outdoor work, and intended for the control of one or two arc lights. It has a snap switch movement and is made at present in 15 and 25-ampere sizes. Since the demand on the clockwork of this switch is said to be lessened, it is in better condition to withstand the variations of temperature encountered in the exterior use of the instrument.

ELECTRIC HOIST.

The hoist shown by Fig. 3 herewith was designed to transfer light work rapidly around shipyards, factories, etc., and when supplied with a trolley carriage, geared-hand cross travel and bridge travel motor, to take the place of small traveling cranes. The manufacturers of the hoist, The Sprague Electric Company, claim for it many advantages. It is said to be highly efficient, to be much smaller and lighter than other hoists of like capacity, and if not greatly overloaded to be very durable. All the different movements necessary for a traveling crane, namely, hoisting, lowering, cross-travel and bridge-travel, are controlled by a simple pulling of the chains and cords connected to the mechanism, and which can be operated by the ordinary workman; no special crane operator or cage being necessary. This is a unique feature, to which special attention is called. The apparatus consists of a chain and chain-wheel, connected by a hardened steel worm and bronze worm-wheel and steel spur gears to a standard Lundell enclosed round-type motor. The thrust of the worm is taken up by hardened steel rollers. The motor is provided with a rotary reversing switch, which works without the use of external resistance. All parts of this switch are made interchangeable. The shaft of the hoisting motor is extended on the commutator end, and provided with a mechanical brake and brake-wheel. This brake is operated by a cam and spring, so arranged that when the starting and reversing switch is in the "off" position, the cam is

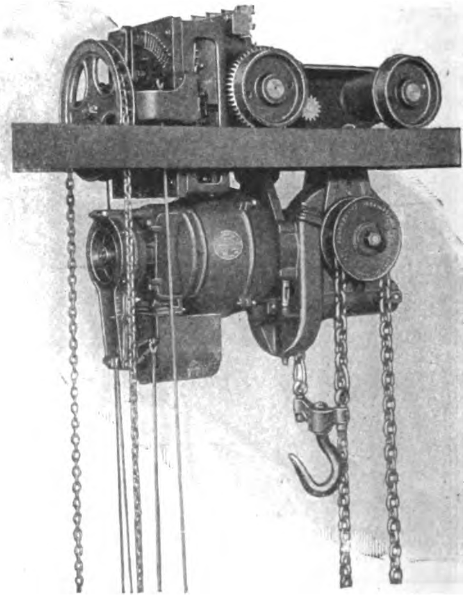


FIG. 3.—ELECTRIC HOIST.

disengaged, and the brake is set. In starting up the motor in either direction by pulling the cords attached to the switch-arm, the cam is thrown against the sides of the brake levers, and lifts the same off the wheel. This arrangement is said to be much superior to a solenoid brake, and in actual practice it has been found that the work can be lifted from a state of rest and raised or lowered one-quarter of an inch or less.

The motor and hoisting mechanism can be hung from two hooks if only a hoisting and lowering motion is desired, or they can be attached to a trolley carriage arranged for cross-travel, either by pushing the load or by a geared hand-traverse motion. A bridge-travel is also provided, the controller for which is mounted on the end of the trolley carriage, as shown in the illustration. This controller is operated by cords, the handles of which are located near the work. The bridge-travel motor itself is mounted in some convenient position on the crane. The bridge travel controller is reversible, and in practice it is said to be possible to move the crane or hoist a distance back or forward not exceeding one-half inch.

The resistance plates for the bridge-travel controller are glass grids, the resistance itself being entirely enclosed by the glass which is cast around the same. These grids have a very large overload capacity.

In designing this apparatus, the manufacturers have carefully kept in view the fact that it would be subjected to rough usage. All parts are made of great solidity, and of the highest grade material, and all bearings have been made self-oiling, requiring but trifling attention at long intervals. The worm gear runs in oil and there is a slight oil gauge on the side of the gear case. The trolley carriage is provided with roller bearings, in order to decrease the effort necessary to operate the cross-travel. No resistance box is used for the hoist motor, and thus one source of annoyance and repairs is done away with entirely.

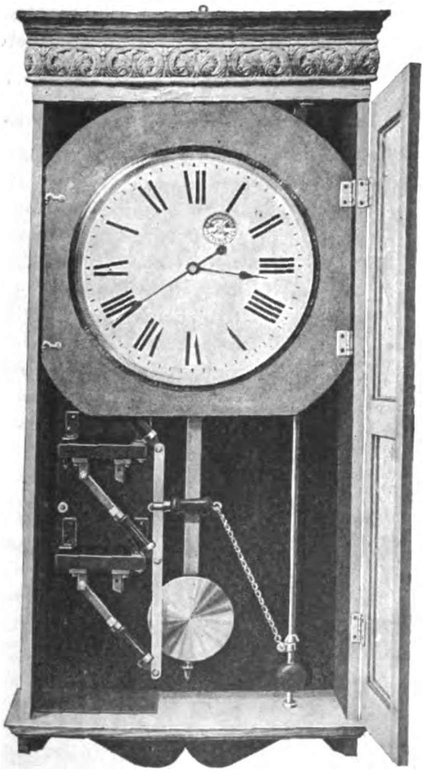


FIG. 4.—TIME CUT-OUT SWITCH.

TIME CUT-OUT SWITCH.

Fig. 4 shows a cut-out or clock switch, brought out by the Baird Manufacturing Company, of Chicago, which is just as available as a public or private time piece as any clock would be, and can also be used for the double purpose of regulator and switch. The clock is a reliable Seth Thomas movement. The switch, which may be either double or triple pole, is of the plain jack-knife type, and is shown in the clock-case below the movement. The switch is attached to the falling weight by a chain, and when once the weight has pulled the switch blades from the jaws, the switch opens under the action of gravity. The high grade of clock used makes the device certain in action. The power of the clock is not utilized, but merely serves to release the weight, which in falling attains sufficient momentum to jerk the switch open.

CONDUIT RODS FOR UNDERGROUND WORK.

A number of essential details are connected with the use and operation of underground conduits, among the most important of which come the rods for pushing the wires through the ducts. Fig. 5 shows the Villard automatic wheeled conduit rod made by Jas. S. Barron & Co, of New York, which is said to possess the qualities of a solid joint having in addition thereto the advantages of being quickly connected and disconnected and of being easily pushed or drawn through the ducts. Heretofore in using rods with joints that were easily detached, a loose joint would cause the rods to buckle when they were pushed through the ducts and under the strain, a zigzag line was formed which destroyed the alignment, and in consequence the ends of the rod were pressed against the sides of the conduit. This caused considerable friction and called for extra strength to manipulate the rods. These disadvantages have, it is said, been eliminated in the Villard automatic wheeled rods, which are very light running owing to their being provided with wheels. The rods are made of hard bronze couplings, the wheels being of chilled cast-iron and the rods proper of seasoned hickory soaked in oil. The rods are secured in the ferrules with a wedge at the inner end, which is said to enable them to stand more tension than they would if they were fastened by an ordinary rivet. The wheels, besides bringing out a quantity of dried dirt or mud also act as a guide to the rods, causing them to take a bend or curve as great as 2½ ft. in 12. The rods are made of hickory 3 to 4½ ft. long and of ⅞ and 1 in. diameter, but iron pipe may be substituted if desired.

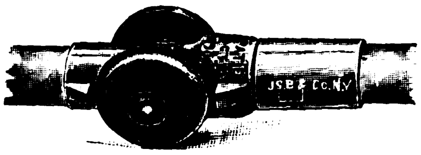
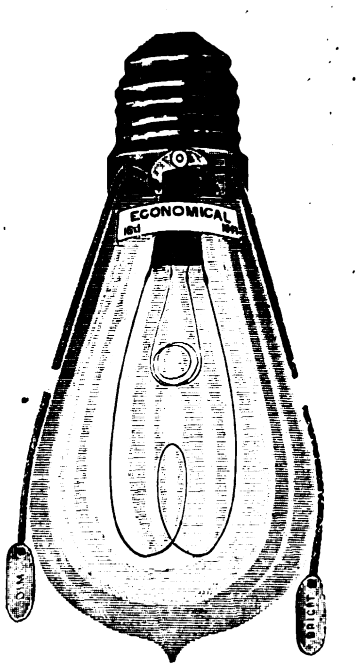


FIG. 5.—CONDUIT ROD.

REGULATING INCANDESCENT LAMP.

Figs. 6 and 6 A illustrate a regulating incandescent lamp which is said to possess the important qualification of being economical in current per candle-power when it is turned down. The lamps are capable of giving two degrees of light, full candle-power or one candle-power.

Fig. 6 shows a lamp designed to be used in any fixture, the operation of changing from one degree of light to the other being performed by the aid of two strings suspended from the lamp base. Pulling one string gives the full candle-power and pulling the other string results in a light of one candle-power. The light can thus be changed without touching the bulb. On the outside of the base a little switch is provided which cuts in one or the other filament according to which of the strings is pulled. There are three terminals, the base of the lamp constituting the common terminal for one end of each of the two filaments, and the second and third terminal points representing the other ends of the filaments. Another design of this lamp is



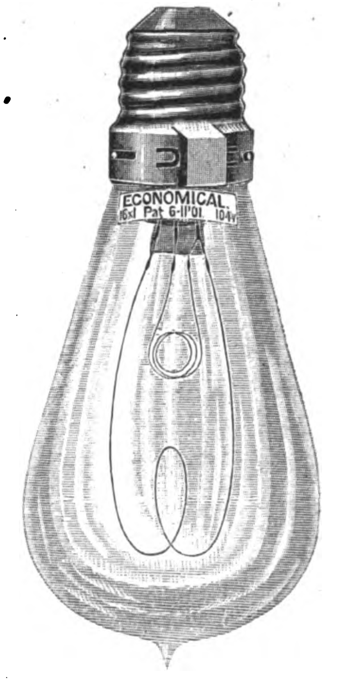


FIG. 6.—REGULATING INCANDESCENT LAMP.—FIG. 6-A.

shown by Fig. 6-A, in which the variation of light is effected by turning the bulb of the lamp in its socket. The base of this lamp is provided with a sliding outside shell which is screwed into the socket in the usual manner. This sliding shell bears the two terminals which shift positions under the contract on the stationary base as the lamp is turned. The lamps are made in two sizes, 8-1 and 16-1 candle-power for all standard sockets, by the Economical Electric Lamp Company of New York.

LARGE CAPACITY CIRCUIT-BREAKER.

The use of very large direct current generators for railway service, and the necessity of handling the large amount of power passing over the transmission circuits, requires that the general mechanical and electrical design of the circuit breaking devices must be of high order to insure the greatest degree of safety and reliability of operation. In the plant of the Boston Railway Company, the Westinghouse Electric & Manufacturing Company found it necessary to build switchboard apparatus of unusual size, the most notable example of which was the automatic circuit breakers. Fig. 7 shows the type of circuit breaker which was installed. It is an enlargement of the standard Westinghouse type "C" circuit breaker and has a nominal rating of 8000 amperes, which makes it one of the largest circuit breakers constructed. This laminated brush type of circuit breaker is made in 1, 2, 3, and 4 pole combinations, each element of the set being provided with an automatic tripping coil which acts independently of the others, or they may be made to operate simultaneously if desired. In general the device consists of an upper and lower contact block connected together by laminated copper brushes. Upon these brushes phosphor bronze springs are placed and upon these are the carbon contacts or arcing points; the brushes are held in contact with the contact blocks by means of a toggle mechanism locked by a trigger attached to the scale beam. The circuit-breaker can be easily closed by hand and will open automatically throughout its entire range. The 8000-ampere breaker has an adjustable range between the limits of 2000 and 10,000 amperes. To avoid any possibility of arcing at the laminated copper brushes, woven copper cables are fastened from these brushes to the carbon arcing points. The automatic action is obtained in a very simple manner and without the use of coils by surrounding the lower contact block with a "U" shaped magnet of laminated iron, and the magnetic circuit is completed by an armature of laminated iron attached to the scale beam. In operation, the action of the circuit-breaker is as follows: The passage of the circuit through the lower stud brushes and upper stud energizes the "U" shaped magnet which attracts the armature. This releases the trigger, unlocking the toggle joint and the copper spring brushes throw the breaker open. In breaking contact, the copper brushes leave the contact block first, aided by the pressure of the brushes which act with the releasing spring instead of against it, followed by the phosphor bronze spring. Then the carbon block or arcing point of the out-moving breaker armature separates from its carbon contacts and its circuit is broken. By this method the current is gradually shunted from the carrying brushes to the carbons, thus preventing any arcing from the metal parts of the breaker.

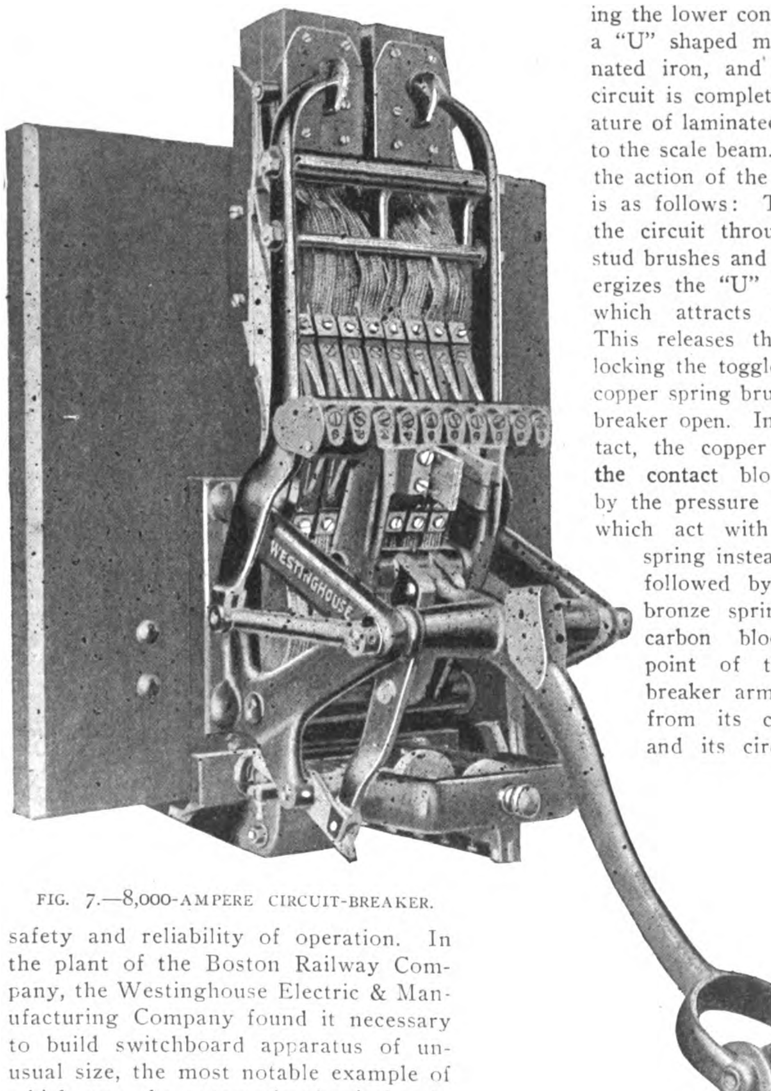


FIG. 7.—8,000-AMPERE CIRCUIT-BREAKER.

ELECTRIC HEATER.

The electric heating outfit shown by Fig. 8 herewith, manufactured by The Simplex Electric Heating Company, Cambridgeport, Mass., was designed to furnish a heater which would be equally useful at home or when traveling. The bottom is recessed so that the cup encloses the heater when set upon it and locks it in place. The heater is made of oxidized steel with a frame of white enamel. It is fitted with a conductor cord, lamp socket, and plug so that it may be connected to either Edison or T-H sockets. It is fitted with an asbestos table pad for use on polished tables which are liable to injury from heat. The cup, which is heavily tinned inside with a nickel finish outside, has a capacity of three half pints. It is 3¼x5 ins., and all the other parts may be easily packed within it. The whole outfit complete weighs 2½ lbs.

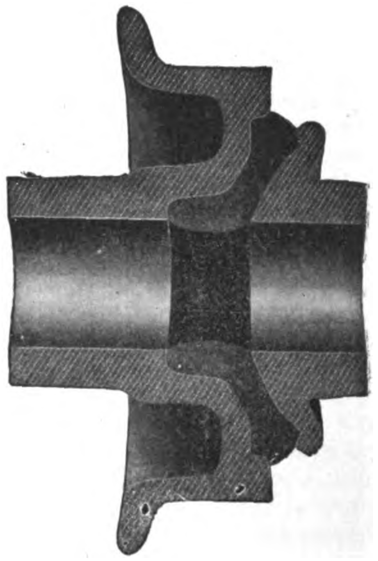


FIG. 9.—SECTION OF ABSORBENT ROLLER.

LINK-BELT ABSORBENT ROLLER FOR CONVEYORS.

Criticism of the wheel conveyor centers upon the rapid wearing of its supporting rollers and their journals. Carriers and conveyors of this class are in wide and extended use, but their introduction has been hampered by the knowledge of the serious and expensive delays resulting from the short life of the carrying rollers. The absorbent roller manufactured by the Link-Belt Engineering Company, of Philadelphia, Pa., is provided with fibrous packing which secures the full advantage of capillary attraction in conveying oil to the journal of the roller and combines with this an automatic and convenient means of re-

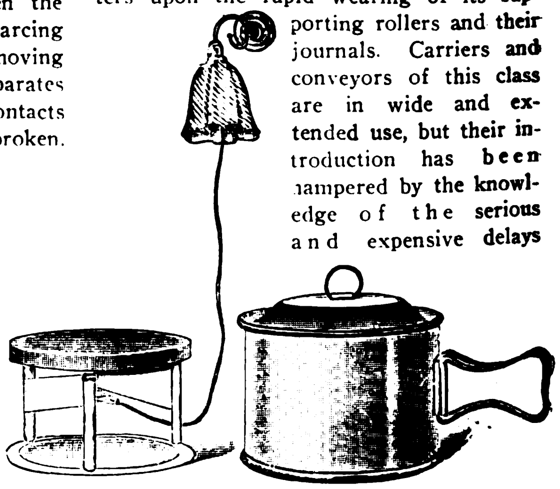


FIG. 8.—ELECTRIC HEATER.

newing the supply of oil. A sectional view of the roller is shown by Fig. 9, while in Fig. 10 is shown a method of supplying oil to the absorbent packing when the carrier is vertical or inclined. Under this condition the oil is fed to the roller from an overhanging reservoir, the feed being governed by small cocks.

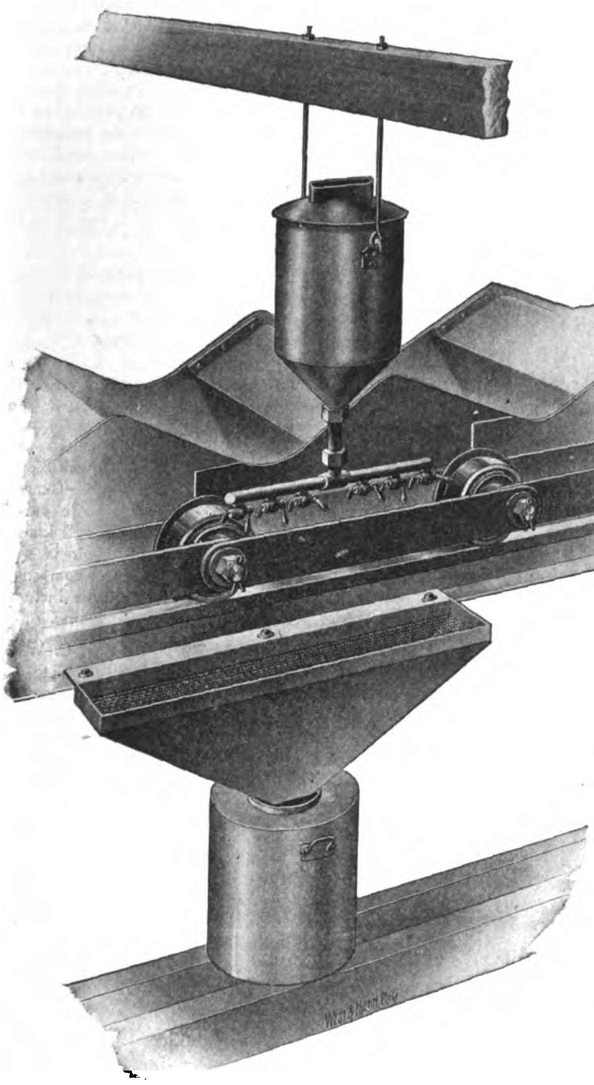
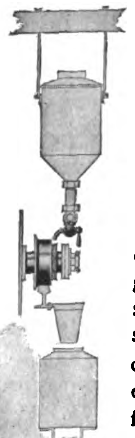


FIG. 10.—LINK-BELT ABSORBENT ROLLER FOR CONVEYORS.



The principle embodied in the device is not limited in its application to conveyors and conveying machinery, but is of value in many other instances.

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NEW BOOKS.

Central Electrical Stations. By C. H. Wordingham. London: Chas. Griffin & Co. Cloth: 496 pages, 6 ins. x 9 ins.; 134 illustrations; numerous charts. Price, $7.50.

The author states that it is his object to produce a work which covers principally those subjects that have heretofore been neglected by technical writers and to avoid discussing such as have been thoroughly treated. The result is a large mass of matter compounded of elementary statements which are largely axiomatic, manufacturers' bulletins and catalogues, and many generalities. The amount of real definite information is small as compared with the number of pages in the book.

The first two chapters deal with the proper education of an engineer and selection of a consulting engineer. Chapter V is on systems of supply, the direct and alternating being compared. The author's conclusion is that single-phase and two-phase alternating currents take twice as much copper as direct current for the same drop and *maximum* e.m.f., and three-phase currents, one and one-half times as much as direct. All of which has no bearing on practice, where effective e.m.f.s only are considered. In Chapter XVII, on switching gear and instruments, switches and circuit-breakers of various forms are described and pictures given, but nothing is said as to current densities in the various portions of these devices, nor separation of poles and length of break for different voltages, which is really the meat of the subject. The chapters on Methods of Charging and Cost of Production are helpful and more nearly cover the ground than do any other portions of the book.

Altogether this work may be described as a general treatise that contains no definite data and more suitable for the stockholder or prospective investor in electrical properties than for the engineer, who could find but little to assist him in it. That there is some little information of value in the book is undoubted, but its usefulness is vitiated by the difficulty of locating it in such a voluminous work.

Armature Windings of Direct-Current Dynamos. By E. Arnold. Translated from the original German by F. B. De Gress, New York: D. Van Nostrand Company. Cloth; 124 pages, 6 ins. x 9 ins.; 146 illustrations. Price, $2.00.

The original work of which this is a translation appeared eleven years ago, and an idea of its thoroughness and worth may best be obtained from the fact that there is not now in use a single fundamental scheme of armature winding that this book does not cover. There are many windings described that are obsolete in the United States and others that were never used here and never will be. The worth of the book to American designers lies in a fundamental formula applicable to all closed-circuit windings, and those examples illustrating its application to the winding schemes employed in this country. For these alone, the book is well worth its price.

Arithmetic of Electrical Measurements. (Ninth edition). By W. R. P. Hobbs. Revised by Dr. Richard Wormell. London: Thos. Murby. New York: D. Van Nostrand Company. Cloth; 112 pages, 4½ ins. x 7 ins.; 8 illustrations. Price, 50 cents.

In this edition the well-known Hobbs "arithmetic" has been carefully modernized as to terminology, and some explanatory paragraphs and definitions have been added, to much advantage. It is to be regretted that the reviser did not also modernize the nomenclature in conformity with the system adopted by the International Congress nine years ago. Many of the examples might have been also revised to the advantage of the student, the treatment in many cases being extremely pedantic. Algebra is employed throughout, notwithstanding the fact that more than half of the assumed cases require the application of mere arithmetic and common sense. To students who already have a knowledge of algebra the book will be extremely helpful; to others, useless.

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LEGAL NOTES.

AUTOMATIC CEILING FAN LUBRICATOR.—A suit brought by the Emerson Electric Manufacturing Company, St. Louis, Mo., against Van Nort Brothers Electric Company, for infringement of the Meston patent covering the method of lubrication employed in the Emerson ceiling fans, has just been decided in favor of the Emerson Company by Judge Adams, sitting in the United States Circuit Court for the Eastern Division of the Eastern District of Missouri.

STANLEY TRANSFORMER PATENT.—Judge Colt, sitting in the United States Circuit Court for the State of Massachusetts, on July 1 denied a motion for a preliminary injunction applied for by the Westinghouse Electric & Manufacturing Company under a recent decision upholding the validity of a fundamental transformer patent issued to Wm. Stanley, Jr., March 1, 1902, and assigned to the Westinghouse Company, with which company Mr. Stanley was connected when the application for patent was filed. The suit was brought nominally against the Saranac Lake Electric Light Company, but defended by the Stanley Electric Manufacturing Company, who built the transformers used by the Saranac Company. The specification of the patent in litigation contains what has been called the "Stanley Rule," which is that the proper length of wire in the primary coil may be determined by connecting the transformer in circuit with the dynamo with which it is to be used, and then winding on wire until the C^2R loss with the secondary circuit open equals a certain value. If this rule is held to be the limiting feature of the patent, modern transformers do not infringe it, and the argument hinged on this particular point. The Court's decision was that the "Stanley Rule" is the main contribution that was made to the art, as disclosed by the patent, and constitutes the principal and most essential part of the invention covered by the patent. The motion for injunction was therefore denied.

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OBITUARY.

ALBERT CLARKE WHITE, general manager of the Providence Telephone Company, died at his home in Providence, June 27, of heart trouble. Mr. White was a pioneer in the telephone field and one of the most prominent and active workers in that branch of the electrical industry. He was born June 28, 1841. His first electrical work was as telegraph operator for the Western Union Company, in which service he quickly rose to the position of chief operator at the Providence office, where he remained until he entered the telephone business in 1881. Mr. White leaves a widow and six children.

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PERSONAL.

MR. A. N. ABBE, of New Britain Conn., has been appointed purchasing agent for the American Hardware Corporation of that city.

MR. J. C. MOULTON, who was for some time connected with Stanley & Patterson, is now identified with the New York office of the Fort Wayne Electric Works.

MR. CHARLES P. STEINMETZ, president of the American Institute of Electrical Engineers, and chief of the General Electric Company's technical staff, has received the honorary degree of A.M. from Harvard University.

MR. FRANK GIBBONS VAUGHAN, of the General Electric Company's staff in Schenectady, was married recently to Miss Alma Demmick, of Lynn, Mass. Mr. and Mrs. Vaughan will be at home in Schenectady after August 1.

MR. J. W. PETERSON, who was formerly connected with the Chicago sales department of the Stanley and Northern companies, has been elected vice-president and general manager of the Electrical Equipment Company, of Chicago, Ill.

MR. E. W. GOLDSCHMIDT, of the Bullock Electric Manufacturing Company's Chicago office, has been appointed sales manager at the New York office to succeed Mr. Robert T. Lozier, who takes charge of the general sales organization at Cincinnati.

KANE-MARTIN.—Mr. Fred L. Martin, a well-known and popular member of the Kellogg Switchboard & Supply Company's staff, was married on June 17 to Miss Lillian May Kane, of Bluehill, Me. The American Electrician tenders its best wishes to Mr. and Mrs. Martin for a happy and prosperous future.

MR. FRED L. BARRETT, at present superintendent of the Peninsula Electric Light & Power Company at Houghton, Mich., will engage in the electrical contracting and supply business in that city shortly and desires to have manufacturers send him their catalogues and wholesale prices. It is his intention to thoroughly cover the upper peninsula of Michigan.

MR. LOUIS A. FERGUSON, president of the National Electric Light Association, has been elected second vice-president of the Chicago Edison and Commonwealth companies by the directors of those companies. Mr. Ferguson will continue to discharge the duties attendant to his previous position of general superintendent, although that title has been abolished.

TRADE PUBLICATIONS.

THE MONOPLEX TELEPHONE. Atwater Kent Manufacturing Works, Philadelphia, Pa.—A vest-pocket folder presenting the advantages of this little telephone outfit.

ELECTRIC FAN MOTORS. Electric Material Company, Baltimore, Md.—A small catalogue containing illustrations and prices of fan motors of various standard makes.

TELPHERAGE. United Tepherage Company, New York.—Circulars Nos. 22, 23 and 24, illustrating some of the manifold applications of the electric telpher system built by this company.

STEAM SPECIALTIES. The Sims Company, Erie, Pa.—Catalogue D, devoted to Sims feed-water heaters, steam separators, oil extractors, exhaust heads, etc.

PORTABLE CRANE AND HOIST. The Franklin Portable Crane & Hoist Company, Franklin, Pa.—A handsomely-executed catalogue of pocket size, containing illustrations and data relating to this very convenient appliance.

TELEPHONE APPARATUS. The Sumter Telephone Manufacturing Company, Sumter, S. C.—Bulletins Nos. 20, 21 and 28, containing illustrated descriptions of the Sumter "bull's-eye" express switchboards and individual telephone apparatus.

TRANSFORMERS FOR HIGH POTENTIALS. General Electric Company.—This is publication No. 9,103, executed in the usual elaborate style of this company's literature and devoted to transformers for 6,000 volts and upward.

RAILWAY CAR TRUCKS. J. G. Brill Company, Philadelphia, Pa.—A handsome catalogue devoted to the well-known No. 27 Brill truck, which is of the bogie type designed, of course, for use on double-truck cars.

AUTOMOBILE EQUIPMENT. Westinghouse Electric & Manufacturing Company.—This is Circular No. 1059, devoted to automobile motors, controllers, charging plugs, cut-out switches, and other electrical appurtenances for motor vehicles.

RAIL BONDS. American Steel & Wire Company.—A nicely-executed catalogue of convenient size, containing descriptions and illustrations of Crown and United States rail bonds, together with manual and hydraulic compressors for applying them.

SOFT WATER. The J. S. Toppan Company, Chicago, Ill.—This is a booklet devoted to the Kennicott system of softening water for use in locomotive boilers. A general description of the apparatus, together with illustrations and records of analyses are given.

THE HARTLEY MOTOR. Wagner-Hatch Motor Company, Chicago, Ill.—A beautifully-executed catalogue containing a detailed description of the Hartley Type C motor, which is of the four-pole semi-enclosed type and is built in sizes ranging from one-eighth to 7½ horse-power.

SUPERIOR GASOLINE ENGINE. Lake Shore Engine Works, Marquette, Mich.—A catalogue devoted to the Superior gasoline engines, which are made for both marine and shore service in sizes ranging from one-half horse-power up to 30 horse-power, and from single-cylinder to quadruple-cylinder.

INSTALLATIONS. Gregory Electric Company, Chicago, Ill.—A nicely-executed publication containing a list, geographically arranged, of machinery thus far installed by the Gregory Electric Company. The list is a long one, including almost every State in the Union, and a considerable number of plants outside the United States.

KEY CHAINLET. John A. Roebling's Sons Co., Trenton, N. J.—This is an attractive souvenir in the shape of a flexible white-metal cord or chain intended for use in place of the ordinary key ring. The ends are held together by a screwed joint, which is jammed by means of a lock washer between the two halves of the joint.

A BOOK OF CURVES. The Electric Storage Battery Company, Philadelphia, Pa.—This publication presents a large number of curves taken from storage battery installations operated under various conditions, which illustrate better than any amount of argument could do the usefulness of storage batteries in combination with electric power generating machinery.

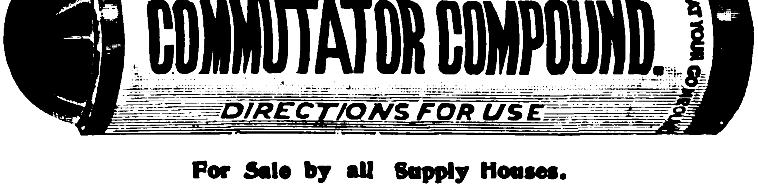
PUMPING MACHINERY. The Stilwell-Bierce & Smith-Vaile Company, Dayton, Ohio.—General catalogue No. 42, devoted to Smith-Vaile pumping machinery, the line of which is too well known to require extensive review. The book is well executed in conformity with all of this company's publications, and the list of illustrations includes at least one of each distinct type of machine.

ADJUSTABLE FIXTURES. The O. C. White Company, Worcester, Mass.—A very complete and well-executed catalogue containing illustrations, prices and descriptions of the comprehensive line of adjustable incandescent-lamp fixtures manufactured by this company. The catalogue also contains a telegraph code supplementary to the standard Western Union code book.

STORAGE BATTERY. The Willard Storage Battery Company, Cleveland, Ohio.—This is the first catalogue of the new Willard Storage Battery Company, which recently succeeded the firm of Sipe & Sigler in the manufacture of this well-known battery. The catalogue is of standard size and of the usual character, containing illustrations and prices of the various cells, together with instructions for handling them.

SWITCHES. Stanley Electric Manufacturing Company, Pittsfield, Mass.—Bulletin No. 127, containing illustrated descriptions of the principal switches of the Stanley line, ranging from the smallest voltmeter plug switch up to switches for 30,000-volt circuits. Tables are given containing all the important dimensions of the various switches, together with the usual data as to capacity and other features.

A COMMUTATOR NECESSITY.



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The Only Article that will Prevent Sparking.
Will keep the commutator in good condition and Prevent Cutting.
Absolutely will not gum the brushes.
It will put that high gloss on the Commutator you have so long sought for.
50c. per Stick. $5.00 per Dozen.

K. McLENNAN & CO.
Sole Manufacturers,
909-100 Washington Street, CHICAGO

THE ELBLIGHT SYSTEM. The National Electric Improvement Company, New York.—This is a catalogue of folio size, devoted to the Elblight system of decorative incandescent lighting. The features of the system consist broadly of an incandescent lamp with two pins serving as the filament terminals and back-boards into which the lamps may be stuck at any position, the pins making contact with the two sides of the circuit.

MOTOR-DRIVEN TOOLS. Crocker-Wheeler Company, Ampere, N. J.—Bulletin No. 24, containing handsomely-executed illustrations of Crocker-Wheeler motors adapted to the driving of various and widely differing machines. The machines thus driven include heavy punching presses, drill presses, back-geared shapers, rail straightening presses, engine lathes, refrigerating machines, milling machines, band saws, slotting machines, stamping presses used in the United States Mint, huge double-head planers, bending rolls, etc.

GREEN'S ECONOMIZER. The Green Fuel Economizer Company, Matteawan, N. Y.—A catalogue of standard size containing illustrations of the well-known Green economizer and all of its various parts, and also complete directions for the practical operation of the economizer. The book further contains a number of useful tables among which may be mentioned a table showing the percentage of saving for each degree of increase in temperature of the feed-water, a table of chimney heights for different sizes of boiler, and an abridged table of the properties of saturated steam.

SWITCHES. Safety Electric Switch Company, Providence, R. I.—An attractively-executed catalogue containing illustrations and descriptions of quick-acting knife-blade switches for central station use. These switches are all provided with a cam and latch arrangement whereby the blades are not released until after the handle has put a strong spring into tension; the releasing of the latch then allows the spring to pull the blades out of the jaws with a quick snap. The double-throw switches are provided with a centering arrangement which prevents the switch from going all the way over when it is desired to have it stop halfway.

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BUSINESS NEWS.

THE EASTERN AUTOMATIC TELEPHONE COMPANY, of Boston, Mass., has removed its offices to 161 Summer street.

NATIONAL STEAM ECONOMIZER COMPANY has removed from Springfield, Mass., to Norwich, Conn., and is erecting a large factory there for the manufacture of the Keller feed-water heater.

LAIRD & LEE, Chicago, Ill., are publishing a convenient little vest-pocket book, entitled "Practical Compend of Electricity," which contains a considerable quantity of useful elementary information concerning the principles of electricity and magnetism.

PITTSBURGH TRANSFORMER COMPANY, Pittsburg, Pa., announces that a complete stock of Type K transformers is carried at its New York office, 120 Liberty Street, so that orders addressed to this office will be filled just as promptly as those sent direct to the factory.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., reports an unusually brisk demand for the new Scheeffer integrating wattmeter for direct and alternating-current circuits; this meter was described in the AMERICAN ELECTRICIAN for June.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, has just sold two very large Cross oil filters to the United States Steel Corporation for use in the Youngstown (Ohio) works. This sale brings the number of Cross filters used by the United States Steel Corporation up to 108.

WM. B. SCAIFE & SONS COMPANY, Pittsburg, Pa., has appointed Cass Harkins, a well-known manufacturer's agent in Columbus, Ohio, sole agent for the We-Fu-Go and Scaife water softening and purifying systems for the Central Ohio district.

TOM J. GARDNER, Las Animas, Col., is installing a 100-kw. electric lighting plant in that town, which will be in operation shortly and will place the town on equal footing with any of similar size in the country in the matter of electric lighting facilities.

S. B. CONDIT, JR., & CO., Boston, Mass., have been awarded the contract for the new switchboard of the Fitchburg (Mass.) Gas & Electric Company. This is to be a 9-panel board, 23 ft., 6 ins. long, and will be equipped throughout with Elden oil switches and circuit-breakers manufactured by this firm.

COMMERCIAL ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., was recently awarded the contract for supplying all the electrical fittings for the grounds of the prospective St. Louis Exposition. The material to be supplied consists of general fittings of almost every description and the contract price was $36,895.

THE STANDARD VITRIFIED CONDUIT COMPANY is the name of a new concern recently formed to handle vitrified salt-glazed underground conduits and insulators, with general offices at 39 Cortlandt St., New York. Mr. R. W. Lyle is president and manager and Mr. B. S. Barnard, vice-president and secretary.

BAKER & FOX, Brooklyn, N. Y., the well-known firm of searchlight and projector manufacturers, have dissolved partnership by mutual consent. Mr. Arthur W. Fox will continue the business with headquarters at the old location, and will sign the firm's name in liquidation of all accounts outstanding at the time of the dissolution.

THE PELTON WATER WHEEL COMPANY of San Francisco and New York has just contracted with the United Light & Power Company of Georgetown, Colorado, for a new water wheel unit. The San Gabriel Electric Cmpany of Los Angeles, Cal., is replacing its original water wheels (eight in number) of a different manufacture, with Pelton wheels.

THE JEFFREY MANUFACTURING COMPANY'S employees on July 12 enjoyed their seventeenth annual picnic, which was held at Idlewilde Park, Newark, Ohio. The amusements consisted of base ball, races, high jumping, vaulting, and running contests, ladies' thread and needle races, girls' egg races, etc. The event was a wholesale success.

LAKE SHORE ENGINE WORKS, Marquette, Mich., has received a certificate of award and gold medal from the South Carolina Inter-State and West Indian Exposition for its Superior marine gasoline engine. The company states that the award was granted in competition with a dozen or more of the most prominent builders of such engines in the east and west, both four-cylinder and two-cylinder engines being exhibited.

SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

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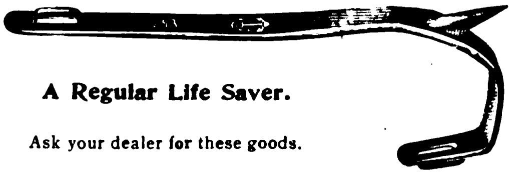

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THE CONSUMERS' INCANDESCENT LAMP COMPANY, Owensboro, Ky., is turning out Premier incandescent lamps in large quantities, notwithstanding the fact that the company has been in operation for only three months. It has a modern plant with a daily capacity of about 300 lamps, and at the present rate of growth it will not be long before the full output of the factory is reached. A. H. Krietler is secretary and general manager of the company.

ELECTRICAL EQUIPMENT COMPANY, Chicago, has been awarded a contract for the complete installation of a 2,500-h.p. electrical transmission plant, the power house for which is to be located on the St. Joe River at Constantine, Mich. The station equipment includes six 400-h.p. and two 60-h.p. water wheels, two 600-kw. revolving-field alternators, and two 35-kw. direct-current exciter dynamos. Each of the alternators will be driven from a shaft to which three of the large wheels are geared, and the exciter dynamos will be driven individually by the small water wheels.

THE CHASE-SHAWMUT COMPANY, Boston, manufacturers of electrical specialties, has entirely reconstructed its factory since the recent fire, on a greatly enlarged scale, and with over double the number of employees. Among the notable improvements is the installation of a De Laval steam turbine for the generation of both power and lighting for the factory. The Chase-Shawmut Company is enthusiastic over this installation and invites inspection of the turbine, which is in constant operation in the factory at 390 Atlantic Avenue, Boston.

THE SIMPLEX ELECTRIC HEATING COMPANY on July 15 took over the electric heating and rheostat business of the Simplex Electrical Company, Boston, Mass., which had been carried on as the Heating Department of that company. The management of the new company will be the same as that of the heating department of the older company. The principal office is located at 77 Cornhill, Boston, Mass. Mr. Jas. I. Ayer is manager of the new company, and the Chicago office will remain in charge of Mr. H. R. Hixson at 1137 Monadnock Block.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, Ill., has closed a contract with the Keystone Telephone Company, Philadelphia, Pa., for the switchboard for its fourth district exchange. The board will be equipped at the outset for 3420 lines and will have room for an ultimate equipment up to 7200 lines. The contract includes all necessary power apparatus, distributing frames, etc. The company has also received a contract for an additional equipment of 1080 lines to the Los Angeles (Cal.) exchange. This will bring the capacity of that exchange up to 7080 lines to start with.

THE SPRAGUE ELECTRIC COMPANY, New York, is hauling in contracts hand over hand for generators and motors. Among recent contracts were the following: Nine 35-h.p. motors, one 30-h.p. motor, and eight 15-h.p. motors for the Atlas Portland Cement Company; 15 10-h.p. motors, 17 25-h.p. motors, and one 50-h.p. motor for the E. W. Bliss Company; one 300-kw. belted generator, one 230-hp. motor and six smaller motors, aggregating 100 horse-power, for the Lehigh Portland Cement Company, and a complete ventilating plant, consisting of American blowers direct driven by Lundell motors, for the Government Printing Office at Washington, D. C.

THE WHITLOCK COIL PIPE COMPANY, of Hartford, Conn., has been awarded the contract for the feed water heaters for the Kings Bridge Power Station of the Third Avenue Railroad Company of New York city, by Westinghouse, Church, Kerr & Company., the engineers. This is one of the largest single orders for feed water heaters ever placed in the United States and comprises 25,000 horse-power of the American standard copper coil feed water heaters of the Whitlock Company's latest improved design, which will be furnished in four units, making these probably the largest coil heaters ever constructed.

THE CLARK AUTOMATIC TELEPHONE SWITCHBOARD COMPANY, Providence, R. I., at its recent annual meeting elected the following officers: E. L. Freeman, president, J. W. Phillips, vice-president, A. S. Clarke, secretary, M. E. Torrey, treasurer, and J. L. Putnam, manager. The following were elected directors for the ensuing year: E. L. Freeman, J. W. Phillips, A. S. Clarke, M. E. Torrey, E. M. Prindle, W. H. Herrick, W. S. Ballou, G. H. Smith, J. H. Preston, A. E. Farwell, A. Van Wagenen and J. L. Putnam. The Clark company now has agencies in all the leading cities in the United States, Hawaii, Europe, South Africa, Australia and Mexico. Recent sales include the International Paper Co., Wilder, Vt.; the National Cash Register Co., Boston, Mass.; Canada Sugar Refining Co., Montreal; United States Trust Co., Boston, Mass.; the towns of Larchwood and Doon, Iowa; Garteiz Hermanos and Yermo & Co., Gijon, Spain, and the East Haven Telephone & Electric Co., East Haven, Conn.

WESTINGHOUSE, CHURCH, KERR & CO., New York, reports an extremely heavy business in engines. Among orders taken during the past month were one from the New York Edison Company for two 6000-h.p. vertical three-cylinder compound engines to supplement the eight Westinghouse engines of this type now running or in course of erection at the Waterside station; one from the Rapid Transit Subway Construction Company for three 1250-kw. turbine-generator sets, and also two 400-h.p. Westinghouse vertical cross-compound engines direct connected to Westinghouse dynamos, which will serve as exciting units for the power station; and orders from the Syracuse Railway Construction Company for two 1000-h.p. cross-compound horizontal Corliss engines, and the Springfield Street Railway Company for one 3000-h.p. vertical cross-compound engine driving a railway generator. The company has now under construction seven steam turbines for the two large railway systems of London, England, which will be the largest steam turbines ever built. The seven units will aggregate 41,000 kilowatts output, and the largest of these will have a capacity of 5000 kilowatts at maximum economy.

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American Electrician.

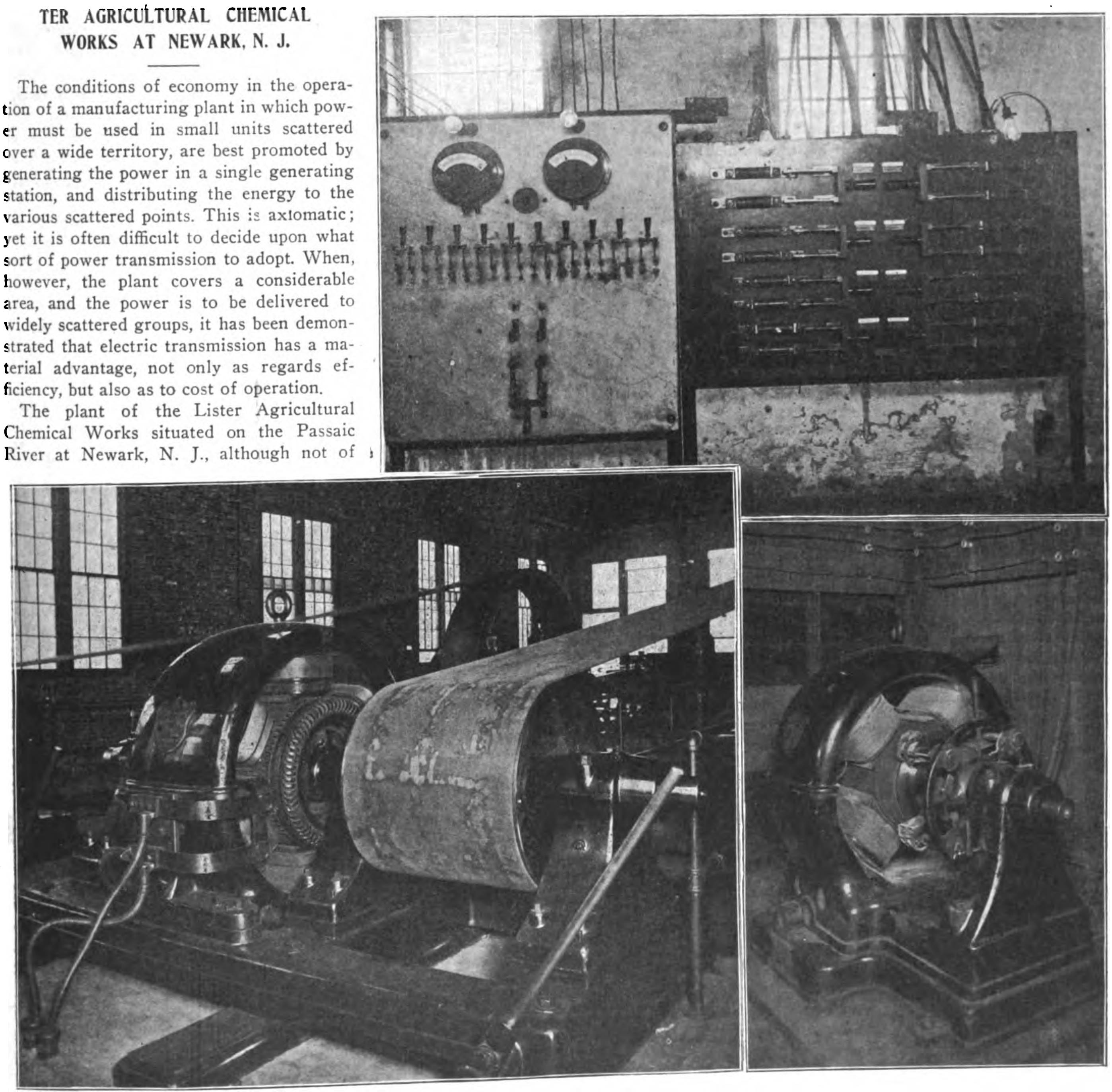
Vol. XIV. New York, September, 1902. No. 9.

AN ELECTRICALLY OPERATED MANUFACTURING PLANT.

DISPLACEMENT OF STEAM BY ELECTRICITY AS MOTIVE POWER IN THE LISTER AGRICULTURAL CHEMICAL WORKS AT NEWARK, N. J.

The conditions of economy in the operation of a manufacturing plant in which power must be used in small units scattered over a wide territory, are best promoted by generating the power in a single generating station, and distributing the energy to the various scattered points. This is axiomatic; yet it is often difficult to decide upon what sort of power transmission to adopt. When, however, the plant covers a considerable area, and the power is to be delivered to widely scattered groups, it has been demonstrated that electric transmission has a material advantage, not only as regards efficiency, but also as to cost of operation.

The plant of the Lister Agricultural Chemical Works situated on the Passaic River at Newark, N. J., although not of very great magnitude, furnishes a good example of the benefits and saving to be derived from the electrical operation of a plant where the conditions are as stated in the preceding paragraph. Here, prior to the installation of electric motors, there were some 16 simple engines scattered over the works, ranging from 12 to 80 horsepower, and fed from various boilers, also scattered. Aside from these engineering defects the steam consumption of some of the engines was as high as 60 lbs. per horsepower hour. The saving resulting from the electric equipment of the works and the concentration of the power in a single generating station was about $7,000 per year



FIGS. 1, 2 AND 3—VIEWS OF ENGINE ROOM, DISTRIBUTING BOARD AND BELTED OPEN-TYPE MOTOR.

for coal alone, and the pay-roll was reduced by $3,780; other savings carried the total clear gain to about $11,000 per year. Moreover, while these figures show a substantial saving, the plant installed has a capacity 55 per cent. larger than the combined capacities of the old steam units.

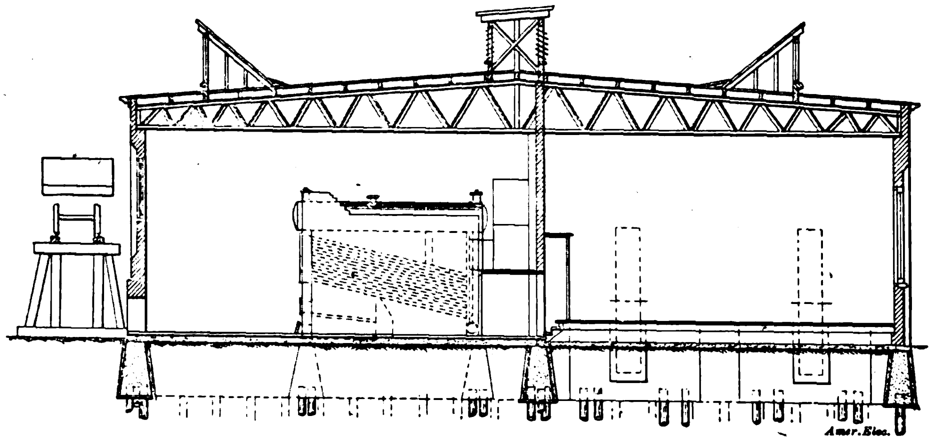


FIG. 4.—TRANSVERSE SECTION OF POWER HOUSE.

Anyone at all familiar with agricultural chemical works where bone black, fertilizer, glue, grease, etc., are made from bones gathered from all quarters of the globe, or those who by mere chance have occasion to pass by the works, will readily agree that the atmosphere surrounding it is quite acrid, while the air in the buildings themselves is heavily laden with fine bone dust. These are not ideal conditions under which to operate any kind of machinery, so that the motors, besides being enclosed, in many instances, are housed in, making it almost impossible to obtain photographs for illustrative purposes. In no case are the motors direct connected. Four classes of motor are used—totally enclosed, semi-enclosed, back-geared and open. The enclosed motors are used where the bone dust freely circulates in the air; the semi-enclosed motors are so arranged as to permit of their being entirely enclosed should circumstances warrant it, but they are rated on the semi-enclosed basis; the back-geared motors have self-contained frames which provide for substantial back bearings, and have semi-enclosed ratings; the open motors are of the standard belted type, having free access to all of the parts. The motor equipment was installed by the Bullock Electric Manufacturing Company.

Fig. 5 is a plan view of the generating station, and Fig. 4 shows a transverse section. The arrangement of the boilers and engines is clearly shown in the engravings, as is also the railway trestle for the conveying of the coal to the boiler room. Space is provided, as indicated by the dotted lines, for an additional battery of boilers. The smokestack is of tank steel, 150 ft. high, and has a clear internal diameter of 78 ins. It is set on a cast iron bed plate, which is bolted to the foundation. The bottom of the stack, where it is riveted to the base plate, has a diameter of 120 ins., which decreases in a bell shape to 78 ins. The thickness of the tank steel used at the bottom is 7-16 in. for the first 30 ft., and above this it decreases a sixteenth of an inch in every 40 ft.

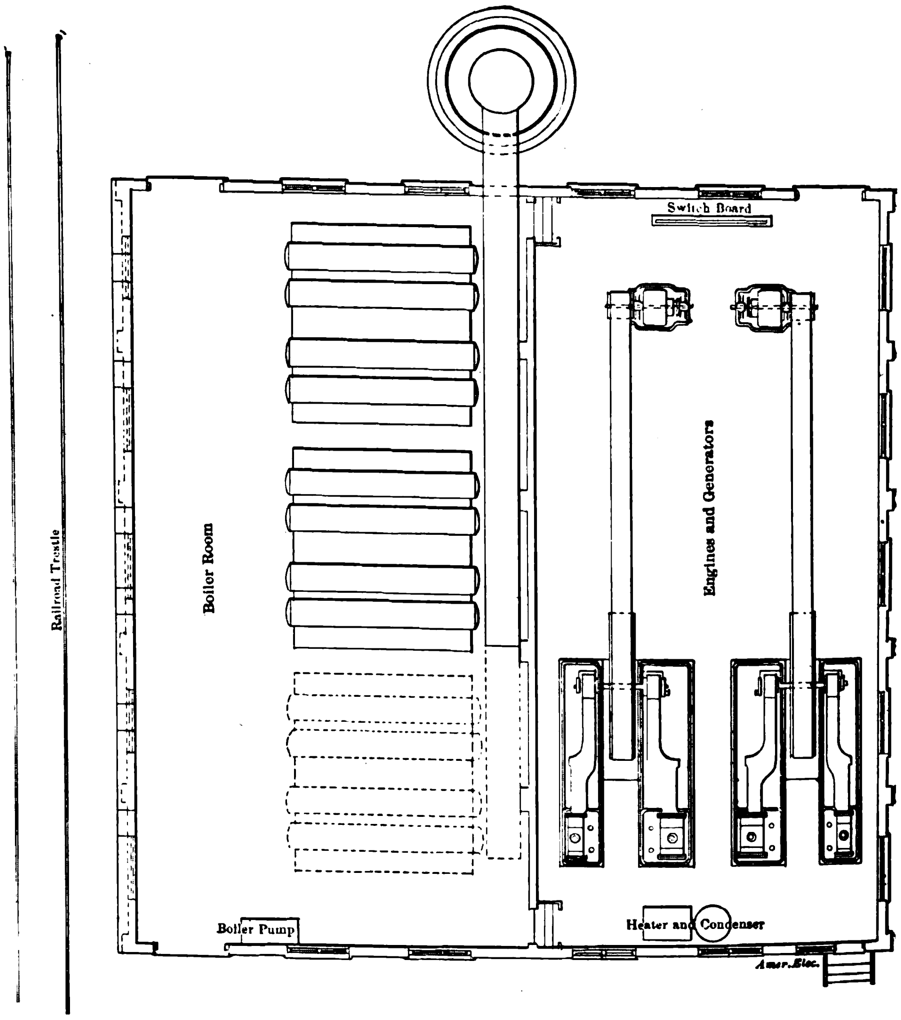


FIG. 5.—PLAN VIEW OF POWER HOUSE.

The boiler room contains four Babcock & Wilcox boilers, set in two batteries, aggregating 1056 horse-power. Each boiler has 14 sections, each section having nine 4-in. wrought iron tubes 18 ft. long; two steam and water drums 36 ins. in diameter, 20 ft. 4 ins. long and ⅜ in. thick. The total heating surface of the boilers is 10,560 sq. ft., and the total grate surface, 119 sq. ft. The fuel used is bituminous coal, hand fired, and brought to the works over a siding from the Central Railroad of New Jersey.

At a proper distance above the ground, as shown in Fig. 4, a breeching nozzle makes connection with the boiler breeching. For the support of the breeching 4-in. I-beams are set between the back of the boiler walls and the partition wall of the building. On these is placed a boiler breeching made of No. 10 steel properly braced. The breeching is about 56 ft. in length, and extends from the boiler farthest from the stack, at which point it is 5 ft. high by 4 ft. wide, to the stack where it is 10 ft. high by 4 ft. wide. Where the breeching passes each boiler there is a nozzle connecting it with the uptake of the boiler.

The live steam lines are installed for a working pressure of 150 lbs. On each of the 8-in. boiler outlets is placed a 6-in. flanged gate valve. Placed on top of this and connecting it with the 10-in. header is a 6-in. wrought iron bend. The main pipe header has in it a 10-in. flanged gate valve next to which is a 10-in. by 6-in. flanged tee for connection to the auxiliary header. The header line extends to a point just inside the north wall of the building terminating in an 8 x 2½ x 10-in. tee. On the 6-in. tee for connection to the auxiliary header is placed an extra heavy gate valve to which is bolted a flanged elbow, and a 6-in. pipe runs directly under the main header to a 6 x 2½ x 5-in. tee, the 5-in. outlet being connected to the engine feed by a brass pipe and gate valve. The 2½-in. outlet is connected with fittings and valve to the feed-pump steam line.

Fig. 6 is a diagram of the steam piping.

Live steam is supplied to the engine through an 8-in. line running along the inside of the north wall of the engine room to an 8 x 6 x 4-in. tee. To the 6-in. outlet of this tee is connected a pipe which runs along the wall to the 6 x 4-in. elbow at the northwest corner. In this pipe is placed a 6 x 1½-in. flanged tee for steam connection with the condenser. The two 4-in. outlets of the tee and elbow are connected by means of 4-in. pipe to the throttle valve of the engine, turning down from a horizontal position by means of a flanged elbow and connecting to the throttle valve through a vertical steam separator.

On the 2½-in. outlet of the 8 x 2½ x 10-in. tee is placed a companion flange, and screwed connections are made for the steam supply of the pumps. This consists of a 2½-in. pipe leading to a 2½ x 2 x 1½-in. tee, the 1½-in. outlet of which connects with the steam supply of one of the pumps, and the 2-in. outlet of which is continued in an easterly direction to a 2 x 1½-in. elbow, whence connection is made to the other pump. In both of these pipe connections a 1½-in. valve is placed. On the outlet of the 6 x 1½-in. tee mentioned in connection with the engine header, is placed a 1½-in. companion flange, from which connection is made to the condenser inlet, a valve being placed in each line.

On the exhaust outlet of each engine, which is 11 ins., is bolted a companion flange, tapped for 10-in. pipe, into which is screwed a 10-in. nipple of such length that the flanged elbow placed on the same comes over the connection between the high and the low-pressure cylinder. The exhausts pass through fittings, gate valves and 10-in. flanged elbows tapped and bossed for 1½-in. pipe for drip, into a 10 x 14-in. tee to the 14-in. outlet of which is connected an elbow tapped for a 2-in. drip. The exhaust continues up through the roof, and is capped by a 14-in. exhaust head properly dripped. In the line is a 14 x 12 x 14-in. tee connecting with the primary heater and a 12-in. condenser relief valve. The heater, which is of 800 horse-power capacity, is carried by two iron stands resting upon the floor and provided with forked tops.

From the exhaust of the pumps, 2-in. exhaust lines connect into a main 3-in. exhaust pipe which makes connection with the exhaust from the condenser through a 2 x 3 x 4-in. tee. The 4-in. outlet of the tee connects to the inlet of the primary heater, and each of the exhaust connections of the pumps and condenser is provided with a 2-in. gate valve. On the steam outlet of the heater is a 3-in. flanged tee, the bottom outlet having a blank flange bolted on it, while from the other outlet the steam escapes to the atmosphere through a 3-in. exhaust head.

The main feed-water supply line is four inches in diameter, and connects with the city water mains. The pipe runs to a point opposite the suction of the pump marked No. 1 in Fig. 7. At this point a 4 x 4 x 4-in. tee connects with the suction of the pump through a gate-valve. The 4-in. run from this tee continues to a point opposite the suction of the other pump, connecting with the same through a gate-valve. A 3-in. gate-valve connects the discharge of the pumps to a pipe leading to the inlet of the primary heater. At this point in the discharge from pump No. 2 a 3-in. elbow is

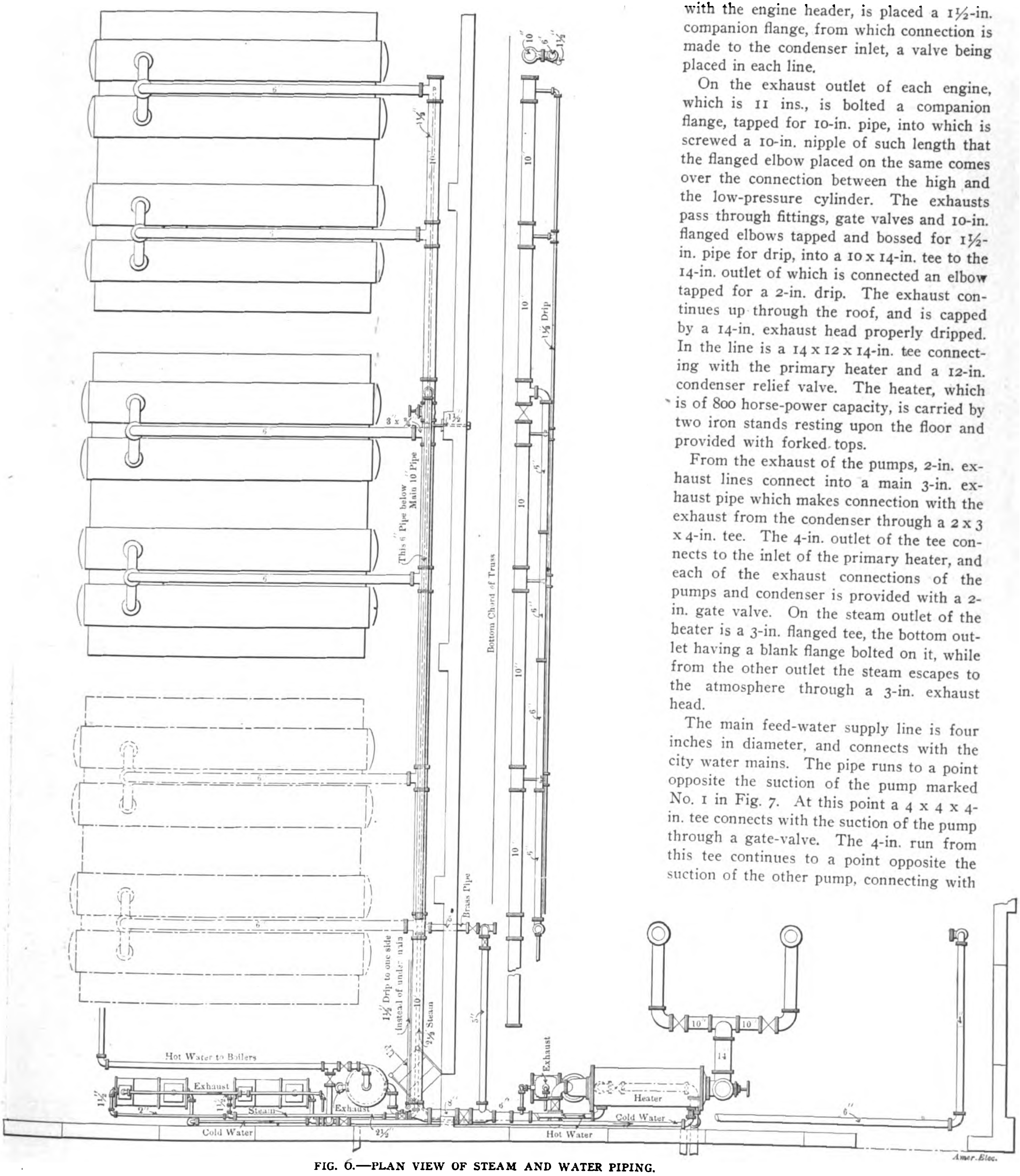


FIG. 6.—PLAN VIEW OF STEAM AND WATER PIPING.

placed, which connects to a 3 x 4 x 3-in. tee, the 3-in. outlet being connected with the discharge from pump No. 1. To the 4-in. run of this tee is connected a 4-in. straight tee having a valve on each outlet, providing a by-pass connection which feeds directly into the boilers. Pipe from the other outlet continues along the wall and connects with the inlet of the primary heater. The discharge from the heater is carried to a point between the boiler and engine rooms opposite the level of the inlet for the water connections. A pipe from the outlet of the auxiliary heater extends in a vertical direction from the top, connecting with the by-pass connection by valves and fittings, and continuing to a point opposite the end of the front of the boilers, whence it is carried the full length of the battery of boilers, as shown. Tees are placed in this line with 2½-in. outlets and connect with the feed pipe of each boiler, the feed pipes having two stop valves and one swing check valve in each line.

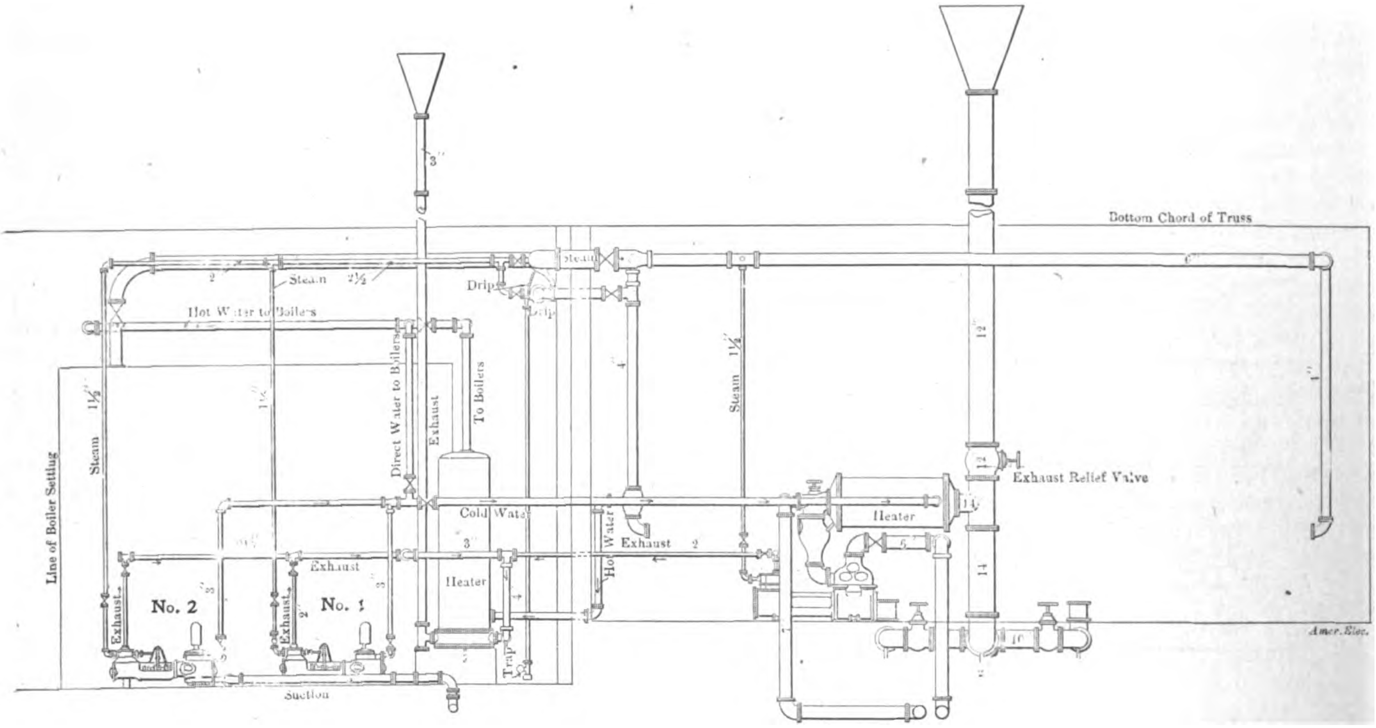


FIG. 7.—DIAGRAM OF STEAM AND WATER CONNECTIONS.

The condenser injection is connected by an 8-in. line to the Passaic River. This line consists of a vertical piece of cast-iron pipe placed in the river about 2 ft. from the bulkhead, the top of the line being about 6 ins. above high-water mark, where an 8-in. flanged elbow is placed. The vertical piece of pipe in the river is about 6 ft. long, and is equipped at the bottom with a Newman continuous-service foot valve. From the elbow mentioned an 8-in. line leads through a trench from the bulkhead and passes through a sleeve in the foundation wall. This sleeve is about 3 ft. below the ground level, and in the middle of the north wall of the engine room. After passing into the engine room, the line connects with the inlet of the condenser. The discharge from the condenser flows off through a 6-in. pipe to the river at about high-water mark. Each of these lines is provided with a gate valve.

The main header line is dripped by means of tapping tees in it for 1½-in. pipe. In the outlets thus made nipples and gate valves are placed, connecting with a 1½-in. drip line, which follows the main header line throughout and connects with a high-pressure steam trap in a corner of the boiler room. The main exhaust is dripped at the bottom of the 14-in. elbow, and also at the 10-in. elbow, and is carried to a "Bundy" condenser relief trap connected with the live steam line, and is equipped with swinging check and gate valves. The drip from the 14-in. elbow is provided with a by-pass connection outside of the building.

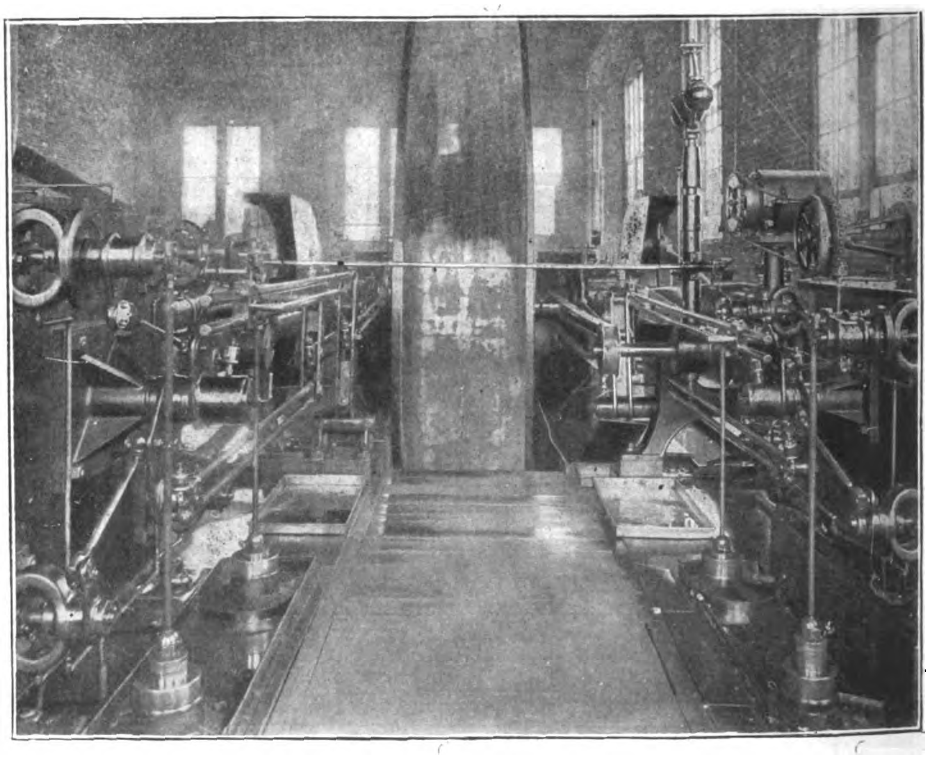


FIG. 8.—VIEW SHOWING VALVE GEAR OF WATTS-CAMPBELL ENGINE.

All the valves working under boiler pressure are designed for 175 lbs. All valves 6 ins. and above on the steam lines are extra-heavy bronze seated gate-valves of the Chapman type, with outside screw and yoke, and all 5-in. valves and under are of the same type, but have inside screw and yoke. All valves on the exhaust lines are of the regular flanged valves of the Chapman type. The valves on the water lines not under boiler pressure are of the wedge pattern, and all valves under boiler pressure, such as on the feed line, are extra-heavy and of the wedge gate pattern. All of the high-pressure steam lines 6 ins. and above are packed by means of extra-heavy corrugated copper gaskets. The fittings and valves on these lines have the face of the flange from the inside of the bolt circle to the outside of the flange turned down 1-16 in. lower than the face of the flange from the inside of the bolt circle to the port. All joints 5 ins. and less on the steam lines, and all joints on exhaust and water lines are packed with 1-16-in. Rainbow packing. All of the pipe running along the walls is carried on brackets and provided with rollers where necessary for expansion.

The engine room contains two direct-current generators built by the Bullock Electric Manufacturing Company belt-driven by two horizontal cross-compound Corliss condensing engines built by the Watts-Campbell Company, of Newark, N. J. The engines have the following dimensions:

Bore of high-pressure cylinder........	14 ins.
Bore of low-pressure cylinder.........	26 ins.
Stroke of each cylinder...............	42 ins.
Diameter of flywheel	14 ft.
Face of flywheel	32 ins.
Weight of flywheel....................	20,000 lbs.
Diameter of main bearings	8 ins.
Length of main bearings............	16 ins.
Diameter of crank shaft..............	10 ins.
Diameter of crank pin................	4 ins.

The engines have a rating of 250 horsepower each when under a steam pressure of 120 lbs., and running at 85 r.p.m. Fig. 8 shows the valve gear of the engines which is of a modified Corliss type. The releasing gear and dash-pots form the notable feature of the valve gear mechanism and a detailed description of these was given in the issue of the AMERICAN ELECTRICIAN for June, 1902. The governor is of the weighted flyball type and it is supplemented in its action against excessive speeds by a Monarch engine stop such as was described in the preceding number of this paper.

The two generators are compound-wound multipolar machines of 240 volts, having a capacity of 200 kilowatts each. They are driven at 500 r.p.m., and carry their full rated load for 24 hours without overheating. The commercial efficiency of the generators ranges from 93.5 per cent. at full load to 85 per cent. at quarter load. The motor equipment which they supply is as follows:

Belted enclosed type.—Two 10-h.p. motors running at 600 and 900 r.p.m., respectively.

Back-geared enclosed type.—Two 10-h.p. motors and two 15-h.p. motors, each running at 900 r.p.m., and giving 150 r.p.m. on the back gearing.

Belted semi-enclosed type.—One 30-h.p. motor, one 20-h.p. motor and one 10-h.p. motor, each running at 600 r.p.m.

Back-geared semi-enclosed type.—One 18-h.p. motor, one 20-h.p. motor and one 10-h.p. motor, each running at 900 r.p.m. and giving 150 r.p.m. on the back gearing, and one 12-h.p. motor running at 1200 r.p.m. and 200 r.p.m.

Open belted type.—One 25-h.p. motor, running at 625 r.p.m., one 50-h.p. motor running at 550 r.p.m., one 90-h.p. motor, running at 475 r.p.m., and one 15-h.p. motor, running at 750 r.p.m.

The back-gear motors have pinions of rawhide, brass bound, meshing into a cut steel gear. All of the motors operate sparklessly under all conditions of normal load, and are capable of taking a momentary overload of 25 per cent. without injurious sparking or heating.

Fig. 9 is a view of the main switchboard in the engine room, and Fig. 2 shows the distributing switchboard in the repair room of another bulding of the works. The main switchboard is of marbleized slate, and contains two 1000-ampere Weston ammeters, a 250-volt Weston voltmeter, two 1000-ampere, single-pole I. T. E. circuit breakers, four 1000-ampere single-pole single-throw knife switches, one 1200-ampere double-pole single-throw knife switch, three 100-ampere double-pole single-throw knife switches, a 6-point voltmeter switch and the usual rheostats. All of the circuits are fused with D. & W. fuses, mounted on the face of the board.

The wiring is in most cases exposed. Outside the buildings and about the yards of the works, it is carried on white glass insulators, on chestnut poles, placed 90 ft. apart. Where the feeders leave the power house a bank of lightning arresters is erected, one arrester being connected to each side

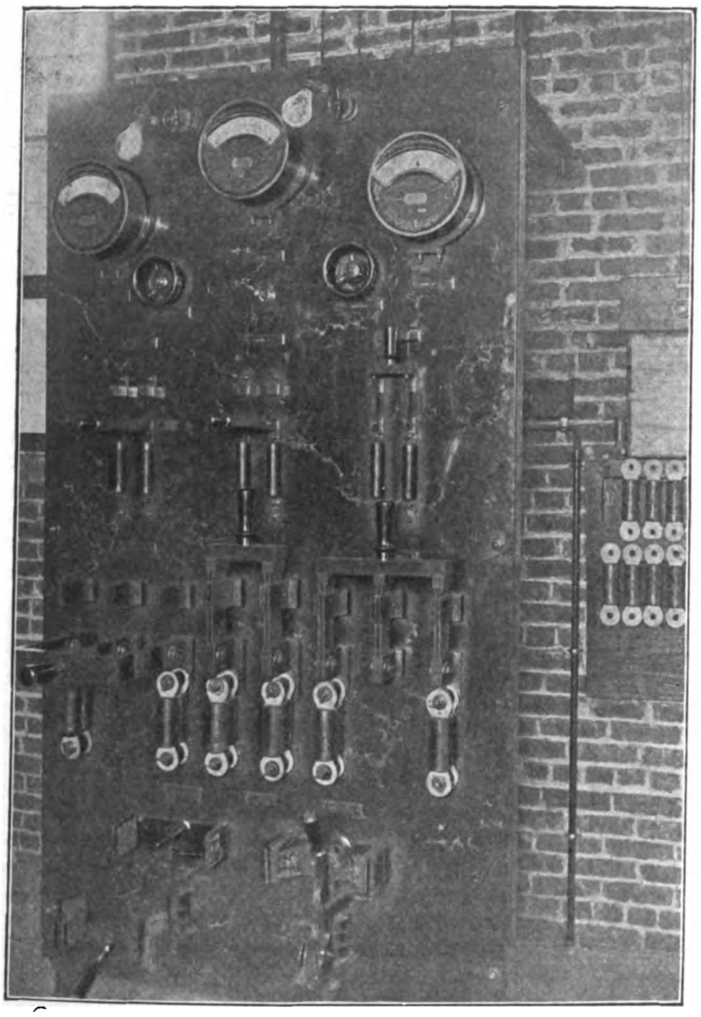


FIG. 9.—MAIN SWITCHBOARD.

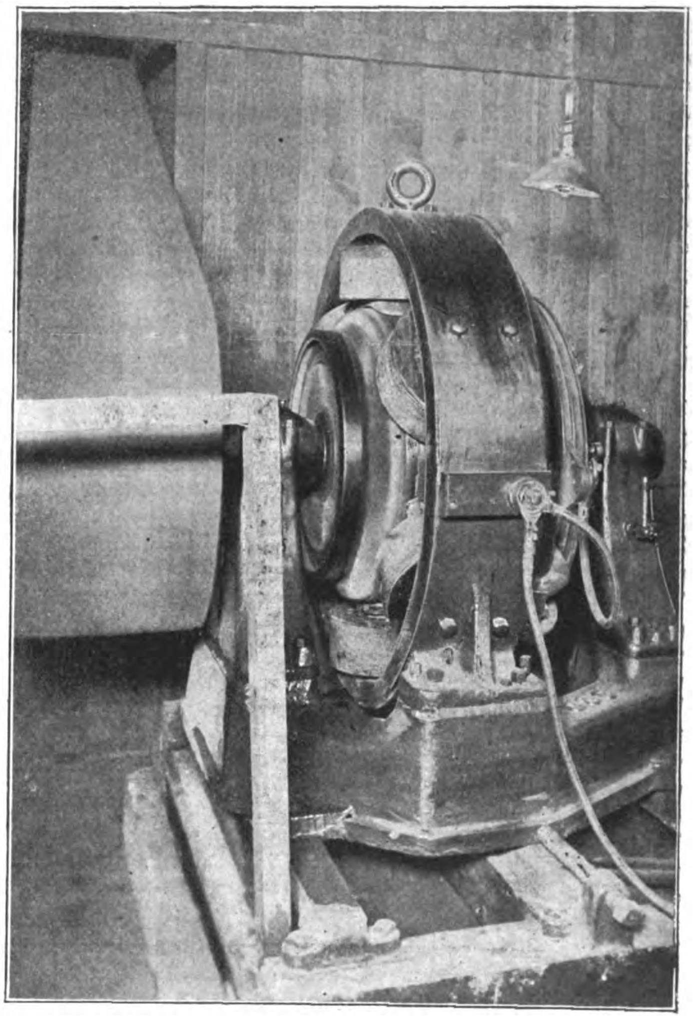


FIG. 10.—BELTED C. & C. MOTOR, WITHIN ITS HOUSING.

of the power and arc-light feeders. The ground connection for these arresters is made as follows: In a hole about 6 ft. square dug to permanent damp earth beneath the arresters is placed a layer of crushed charcoal 2 ft. thick; on this is placed about 25 sq. ft. of No. 16 tinned copper plate. Across the entire surface of the plate is soldered a bare No. 0, B. & S., copper ground wire, and the plate is covered with another layer of charcoal 2 ft. thick. The hole is then filled with well-moistened earth. In addition to soldering, the ground wire is flattened out and riveted to the ground plate by copper rivets.

Where the service conductors enter the buildings they are bushed with porcelain tubes. These tubes are placed in the wall and slant slightly upward from the outside, and drip loops are provided in the conductors. On a basis of motor efficiency of 90 per cent. and lamps taking 4 watts per candle-power, the loss in potential on the main feeder betwen the switchboard and distributing panel does not exceed 7½ per cent. when all motors are operating at full load and all lamps are burning. The drop in potential in the sub-feeders between the distributing panel to the farthest motor and lamp does not exceed 5 per cent.

The feeder system is planned as follows: One main feeder of sufficient carrying capacity for 80 per cent. of the entire load of motors and lamps is run from the switchboard in the power house to the distributing panel, and from the distributing panel sub-feeders are run to several motors and lamp groups. Rubber-covered wire is used throughout for interior work. The completed coverings showed an insulation resistance of 100 megohms per mile. The motor wiring is also rubber-covered, and between the starting apparatus and the motors the wire is encased in iron-armored conduit. Enclosed-arc lamps, built for 220 volts, are used about the yards of the works. All of the interior wiring for incandescent lamps, etc., is carried under glazed porcelain cleats. Where the circuits run on steel girders wooden supports are fastened to the girder by means of wrought-iron girder hooks.

The outside conductors were tested for an insulation resistance of 300,000 ohms between the conductors and between the conductors and the ground. The whole installation, including motors, lights and other appliances, has an insulation resistance of over 240,000 ohms between the conductors and the ground. The engineers for the entire equipment were M. W. Kellogg & Co., New York City.

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Solder for Aluminum.—In a paper read before the Society of Arts, Prof. E. Wilson recommends the following composition as a successful solder for aluminum. The constituents are 28 lbs. of block tin, 3.5 lbs. lead, 7 lbs. spelter, and 14 lbs. phosphor-tin. The phosphor-tin should contain 10 per cent. phosphorus. Clean off all dirt and grease from the surface of the metal with benzine, apply the solder with a copper bit, and when the molten solder covers the metal, scratch through the solder with a wire brush.

EXPERIENCE WITH THE NERNST LAMP.

One of the most interesting of the topical discussions at the recent Cincinnati Electric Light convention was on the subject of the Nernst lamp. The discussion was partly through written communications and partly verbal. A considerable portion of the remarks was contributed by central station men who had had practical experience with the lamp.

Mr. F. H. Golding, of Branford, Conn., reported that the results thus far obtained by his company with the Nernst lamp have been very satisfactory. The customer is required to furnish the lamp and the station supplies renewals free of charge, as in the case of ordinary incandescent lamps. While he thinks the present price is rather high, yet, on the whole, he considers the lamp a commercial success. Mr. W. J. Greene, of Cedar Rapids, Ia., said that thirty-two 106-volt Nernst lamps placed in the office and dining-room of a hotel have given splendid satisfaction so far as light is concerned. The life of the glowers, however, has been short, averaging less than 100 hours. A recording voltmeter shows an even regulation at the proper e. m. f.

The Union Electric Light & Power Company, of Unionville, Conn., has installed 125 single-glower and 15 six-glower Nernst lamps on the street-lighting service, these lamps covering all the street lighting that this company does. From the standpoint of the public, they are giving excellent satisfaction; the light is a pleasant one, and the fact that double candle-power is given for practically the same price is of much satisfaction to the public. From the standpoint of the company, there as yet is not sufficient data to judge of their commercial success, as the lamps have been in use only about five months. It can be stated, however, that the company considers there is no question about the matter, provided a steady voltage is maintained, it having been found that any very serious variations in voltage affect the life of the lamp. The lamps have not yet been run 800 hours, but it is judged that the average life will attain that figure. While the lamps deteriorate somewhat, the deterioration is not so noticeable as it is in an ordinary incandescent lamp.

In the oral discussion, Mr. A. C. Dunham, of Hartford, Conn., said that his company has had the Nernst lamp in use for fifteen months, but principally for experimental purposes to determine its value. Not having any price for either glowers or lamps, it was not possible to determine the comparative economy of the lamp, but the conclusion has been reached that the Nernst lamp is closely related to the arc lamp in the matter of trimming. Every arc lamp is a new lamp every time you trim it; every Nernst lamp is a new lamp every time you trim it, and requires also about the same care in repairing and cleaning, principally cleaning. The question which occurs to everybody is, How often can you afford to trim the lamp and what will it cost as compared with the arc lamp? As regards the relation of the Nernst lamp to the incandescent lamp, the same socket can be used. That the Nernst lamp gives quality of light cannot be questioned. The light is soft, brilliant, but not too bright, and as compared with the Edison lamp, it is a superior light. As to the power question, you may make a great saving in the installation of machinery and in all the various line systems and underground work, by putting in half the current. Mr. Dunham said he expects to install this coming year about 5,000 Nernst lamps, which shows that he has confidence in them. It is a lamp of luxury, as the Edison lamp was within our recollection, when we paid 75 cents for a lamp, and which did not last very long, either; but the Nernst lamp will come within our reach as a bread and butter lamp more rapidly than the Edison, because it has severer competition. It must be put in such shape that it can be manufactured on a large scale, but you cannot reduce prices until you do manufacture on a large scale. The deterioration is less than with the Edison lamp. You get all the advantages of distribution in the Nernst lamp that you get in the Edison lamp, and which you cannot secure with the arc lamp. In concluson Mr. Dunham said he considered that the lamp is certain to prove a success.

Mr. Frank S. Smith reported that the New York offices of his company had used for the purpose of general illumination, 48 single-glower, three 3-glower and six 6-glower Nernst lamps (a total of ninety-three glowers) on a circuit of nominal 216 volts, alternating current. Records show that at times the voltage has been as high as 242 and as low as 194, with an average variation of approximately eight per cent; that is, four per cent above and four per cent below. The character of the light has been all that could be desired. Some little trouble was experienced in the cut-out of the single-glower lamps shortly after installation. These were repaired, and since than have operated entirely satisfactorily.

In the 3-glower lamps a slight humming was noticed when first installed, but that was remedied and there has been no trouble since. Records of the number of glowers replaced were not kept previously to September 1, 1901. From that date to April 18, but sixty-eight new glowers had been put in. In one instance, at least, in a single-glower lamp, there has been but one replacement during the year; this was in a lamp that has operated satisfactorily since the beginning, burning an average of four hours per day, with the glower now apparently in good condition. The care of the lamps has been intrusted to a boy about sixteen years old, whose duties have been to light the lamps in the morning and make replacements of burned-out glowers. It is interesting to note that apparently the best service is received from lamps with more than one glower.

As to what is claimed to be the high price of Nernst lamps, this is natural in view of the presumably large expense involved in the experimentation necessary to bring the lamp to its present successful form. It would be natural to expect, now that the preliminary work is practically over, that the price of lamps will be reduced, so that there can be no reasonable ground for criticism on this score from now on. In conclusion Mr. Smith said that his experience with the Nernst lamp had been such as to demonstrate that in its present shape it is a commercial success. As to the extent to which the lamps are being used, he said that he had observed them in a great many places, and the replies to inquiries as to their successful operation have always been in the affirmative. The matter of renewals is a very simple one, which any intelligent office boy can successfully carry out.

Mr. J. M. Uptegraff, of the Sewickley, Pa., Electric Company, reported that his company is using Nernst lamps for street lighting, and is now installing the lamp for commercial and residence service, the customer buying the lamp and furnishing renewals. For street lighting the 6-glower lamp is used and gives entire satisfaction. The lamps have been in use since October, 1901. The glowers have given an average life of 1300 hours. The lamps are inspected but twice a week—Wednesdays and Saturdays—and all burned-out glowers are renewed on these days. The street lamps are furnished and renewed by the lighting company.

Mr. C. F. Nagle, of Savannah, Ga., reported that experience with the Nernst lamp had thus far been satisfactory to his company and to most of its customers. It was found necessary to use care in supplying glowers of the proper voltage for the current furnished, as excessive voltage will soon destroy the glowers. With normal voltage some glowers will burn out within 100 hours, but if they burn for 100 hours long life seems to be assured. It was found that business can be secured with the Nernst lamp that could not be obtained with either the arc or incandescent, and that it competes successfully with the Welsbach. The cost per kilowatt for supplying current for Nernst lamps is greater than for incandescents, on account of interest and depreciation in addition to cost of renewals and care of lamps, and it has therefore been found necessary to charge a higher rate per kilowatt-hour if the company furnishes the lamps.

Mr. E. F. Phillips, of Detroit, Mich., said that his company had felt the necessity for some time for a lamp to fill the gap between the ordinary cluster and the 500-watt enclosed arc lamp. In quite a number of places the cluster would not give sufficient light, while the 500-watt lamp would give more light than was really necessary; and in other cases one arc lamp would not give sufficient light and two lamps too much; besides, the cost of current to the customer in both cases would be more than circumstances would warrant. The 350-watt enclosed-arc lamp was tried, but with indifferent success, there being little difference in consumption of current between it and the 500-watt lamp, and also much less power of illumination. The Nernst lamp, therefore, appeared to them to meet the conditions above noted, and also to open a field for use of current which the company could not otherwise obtain. It would be a strong competitor of the Welsbach light and of the Humphrey gas arc. Another consideration was that it would serve as an educator in the use of electric lighting with but small expense to the customer. In one instance a Nernst lamp was put in a store where Welsbach burners were in use; after the lamp had been in use a little over a month the customer wired his store for eleven enclosed-arc lamps and about 50 incandescent lamps, abandoning entirely the use of gas. In another case a Humphrey gas arc was displaced by a Nernst lamp to the complete satisfaction of the customer, both as to quality of light and cost.

Following are some observations as to the renewals of glowers and general behavior of the few Nernst lamps Mr. Phillips' company has put in regular service:

Lamp No. 1: Three-glower, installed February, 1; March, all glowers changed on account of burning dim. Current consumed February 1 to April 23, 117.2 kilowatt hours; cost to consumer, $7.55 net.

Lamp No. 2: Three-glower, installed January 29. Current consumed January 29 to April 23, 51.2 kilowatt-hours; cost to customer, $4.77 net. This lamp was burning well May 1, with no change of glowers, and with apparently small decrease in illumination.

Lamp No. 3: Six-glower, installed January 6, at a sub-station to burn all night, every night. This lamp was equipped with a small enclosing globe and shade. January 16, one glower burned out and globe badly blackened. January 23, two glowers burned out. February 28, put in new set of glowers. May 6, one glower burned out. Current used January 6 to May 6, 297.5 kilowatt-hours, with four glower renewals, or one glower to each 74.3 kilowatt-hours, or 1486 50-watt lamp hours.

Lamp No. 4: Six glowers, installed March 4. April 8, one glower burned out. Current used March 4 to May 6, 155 kilowatt-hours, or one glower for 77.5 kilowatt-hours, or 1550 50-watt hours.

Lamp No. 5: Three glowers installed February 25. No renewals. Taken out, and customer installed eleven enclosed-arc lamps.

Lamp No. 6: Three glowers, installed February 26. March 19, one glower burned out. Current used February 26 to April 23, 27.1 kilowatt-hours at cost to customer of $3.20 net. One glower for 540 50-watt lamp hours.

Lamp No. 7: Three glowers, installed March 21. May 7, one glower burned out. Current used, 26.5 kilowatt-hours or one glower renewal for 530 50-watt lamp hours.

Mr. Phillips says he has not been advised as to the price the manufacturers intend charging for new glowers, but figuring on a basis in comparison with lamp renewals at half a cent per kilowatt-hour, in the cases noted, the cost for renewals would be as follows:

Lamp No.	1	117.2	kw.-hours	$.536	3	glowers.
"	2	51.2	"	.256	0	"
"	3	297.5	"	.487	4	"
"	4	155	"	.775	2	"
"	6	27.1	"	.135	1	"
"	7	26.5	"	.132	1	"
Totals		674.5	kw.-hours	$3.371	11	glowers.

showing an average of 30.6 cents per glower.

No record has been kept of inspection, or time consumed thereon, it being more the purpose to observe the working efficiency and adaptability of the lamp to commercial service than to obtain an elaborate record of costs. The conditions observed were that there is a tendency on the part of the glowers to warp, thus bringing them so far away from the heater as to make the lamp very slow in starting up; the shortest time noted being thirty seconds and the longest three minutes.

There has been only one complaint of light becoming dim, and this was only proven when the old glowers and holder were substituted for new ones. It is not thought that this dimming is attributed to the black deposit on the holder, but is due to some defect in the glower itself, as new glowers have been put in partly blackened holders with appreciable difference in the light. Where warped glowers have been found, it has been possible to correct the lighting up by turning them partly over, or bending up the terminals so as to bring the glowers closer to the heater. There has not been any trouble yet from the giving out of the steadying resistance, or heaters. In conclusion Mr. Phillips expressed the opinion that the most important obstacle to be overcome is the prevention of the warping of the glowers, for on this depends the satisfactory operation of the lamp. First, because a glower that is warped will not light up quickly, and will consequently cause complaint from the customer. Second, tardy lighting throws the heater into action for a longer period, and therefore necessitates its more frequent renewals. If this condition is remedied and no further defects are found in their operation—which, from the limited experience, are not looked for—the cost of glower renewals is not excessive. Mr. Phillips felt sure that, owing to the excellent field for it, the lamp should come into quite general use.

At the conclusion of the reading of communications and the oral discussion, Mr. A. J. Wurts made a lengthy communication to the subject. Referring to the citation of a life of 1300 hours, he said that the frequency in this case was 125. As to the remark that if a glower survived 100 hours it would have a long life, it was explained that one of the chief causes of early breakage is mechanical strain on the glower. A glower expands and contracts, particularly at times of lighting and turning off. The glower should be perfectly free and have an end play of about 1/16 of an inch, when no mechanical strain will be brought on the glower and the average life, barring a defective glower or accident, should be 800 hours on 60 cycles. With reference to frequency, the life of the glower is 800 hours on 60 cycles, and 400 hours, apparently, on 25 cycles. There are experiments being carried on in Buffalo on the circuit from Niagara Falls, which indicate a considerable longer life than 400 hours, but these experiments have not been completed, and nothing definite can be said at this time. The figure of 400 hours is based on results obtained from about 250 6-glower lamps which are operated in the factory of the Westinghouse Company on 25 cycles. On 133 cycles the life seems to be about 1200 hours. As to the cost of trimming, there is as yet little data. The Westinghouse Machine Company has a large number of 6-glower lamps in the factory and has kept a record of the labor required to take care of the lamps. The figures indicate that it requires a one-man-hour for 800 lamp-hours on the 6-glower lamp.

As to the direct-current lamp, the Europeans have labored along the lines of a direct-current lamp, exclusively. They have not made the alternating-current lamp, so that the direct-current lamp is not only a possibility, but a fact. In this country it has been found that the life of the glower on the alternating current is much greater than with direct current. The Nernst Lamp Company, however, is now making direct-current glowers and proposes to put them on the market very shortly—probably by the first of September. An interesting feature in connection with this subject is that all lamps will be exactly the same, whether for direct current or alternating current, except the glower. The direct-current glower will be different from the alternating-current glower, and the same remark applies to lamps for different voltages. As an illustration, the six-glower lamp for 220 volts is adjusted for 200, 230, 240, or whatever the voltage is, and the lamps are the same in every respect, except the glower.

As to the position which the lamp must occupy, so far lamps have only been made which will operate in a downward vertical position. The reason is that the cutout operates by gravity and must be maintained in one position. For any special cases the position of the cutout could be reversed in the lamp, and in that case the lamp would operate in an upward vertical position; it has been considered, however, that the light should be thrown downward instead of upward and no steps have been taken to make a lamp which will operate in any other position than the downward. An endeavor has been made to produce a "universal lamp" which will operate in any position, but that will require something in the nature of a spring for a cutout, and it has been found that a spring is not always reliable.

As to the useful life of the glowers, possibly that is a good deal a matter of opinion. The total life of the glower seems to be about 800 hours on 60 cycles. Whether that would be considered the usual life or not, must be determined by the user. Nevertheless, even at the end of 800 hours, the glower still has an efficiency which will compete with other lamps now in use. As to the range of voltage, there appears to be a misunderstanding with regard to the Nernst lamp being very sensitive to changes in voltage. This idea has arisen from the fact, very largely, that in every case the company asks for the accurate average voltage of the circuit upon which the lamp is to be operated, the object being that it could supply a lamp for the best possible satisfaction. In a great many cases where an incandescent lamp is bought and placed on the circuit, and not much attention given to the question of voltage, the life of the lamp is curtailed, but nothing is thought of this and the lamp is replaced; but the Nernst lamp, being new, the customer watches it critically to see whether it lives up to the claims made for it by the manufacturer. As a result, it is thought wise to request reasonably accurate figures with regard to voltage, so that the lamps can be adjusted at the factory for that particular voltage. A large correspondence extending over six months, has shown that very few central station people realize what a very great change there is in candle-power for a very small change in the line voltage. There is a drop of 40 per cent in candle-power in an incandescent lamp for a drop of 5 per cent in voltage. That being the case, it is very important to have the correct voltage if the new lamp is to make a good impression.

The variation of candle-power in the Nernst lamp, going upward, however, is exceedingly small, compared with the variation of the incandescent lamp. The variation in candle-power for a 5 per cent rise in voltage is only 12 per cent in the Nernst lamp. The effect of an increased voltage on the Nernst lamp has been about as follows: Five per cent rise for some hours does not seem to materially affect the life of the glower, but a 5 per cent increase in voltage running continuously, would make a little difference in the life of the glower. A 10 per cent rise running continuously will blacken the ballast tube. A 15 per cent rise will make the ballast tube very black, and a 20 per cent rise will heat the ballast tube sufficiently to soften the containing glass bottle; thus by inspection of the lamp one is able to determine pretty closely how the lamp has been treated. Mr. Wurts said, however, that his experience with the lamp indicated that it is impossible, on account of the very high corrective power in the ballast, to burn out a glower within 200 hours with a rise, say of 10 or 15 per cent. The ballast goes first, but not unless the voltage is raised about 15 per cent and run continuously at that increase. Mr. Wurts said he is very confident that if a glower gives out in less than 200 hours, the breakage is due to mechanical strain.

In reply to a question, Mr. Wurts said the efficiency question is a difficult one to answer satisfactorily. He considers that the efficiency of the lamp should be based on its earning capacity. The lamps have been given merely a nominal rating. The one-glower is called a 50-c.p. lamp, which figure was arrived at by measuring the candle-power on the photometer bar in the direction of greatest intensity, and the one-glower lamp gives 50-c.p. in this direction of greatest intensity with a clear glass globe. The company has, however, devised for itself a photometer. In its exhibition room is a ceiling cluster of four one-glower lamps, with the sand-glass globes, and in four corners of the ceiling there are four clusters of three lamps each, of incandescent lamps, clear glass globes, making twelve 16-c.p. incandescent lamps altogether; it is the opinion of everyone who has been in the room that there is a great deal more light, better illumination, from the four one-glower Nernst lamps than the twelve 16-c. p. incandescent lamps. Most people say offhand that twice as much light is given out by the Nernst lamps, but a very conservative figure would be that the Nernst lamps are giving one-third more light. The four single-glower lamps take 352 watts. The candle-power is measured by the twelve 16-c.p. units in the ceiling, all of which have reflectors over them. That is to say the 16-c.p. incandescent lamps are taken as the standard, and with that data and the power supplied to the Nernst lamps, the consumption of the Nernst lamp is estimated to approximate 1½ watts per candle.

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TELEPHONE ENGINEERING.

BY F. J. DOMMERQUE.

LOCATING A POLE LINE.

Having decided to install a telephone plant in a city or town, the first step in the process of installation is to solicit or plan the main routes for a pole line so that each subscriber's line will approximate as nearly as possible to a straight line from the office or residence of the subscriber to the telephone office. If no route approximating a straight line can be found, select the route which combines the shortest distance with the fewest curves and corners, as the presence of the latter necessitates not only more costly line work, but also complicates the construction of the line. Some of the many factors that enter into the judicious selection of a pole line route in a town or city may be presented here.

First, in towns having electric street railways, it will be found inadvisable to give a moment's thought to using grounded circuits, as they will never be free from disturbing noises. Hence, pole lines must be planned to carry metallic circuits. But it is not advisable to place even these circuits on the same street with electric railway lines, for some of the telephone lines will necessarily be carried above the railway wires at one or more points, especially in connecting up residence subscribers' instruments.

Second, should the telephone wires be broken by high winds or by heavy sleet storms, or by falling branches, or by any other of many causes, and fall across the trolley wires, much damage to the equipment may follow from the trolley circuit burning out coils in switchboards and telephones; occasionally a serious fire may occur through wires so crossed; and cases are on record where horses have been killed by coming in contact with fallen telephone wires that dangle over and touch trolley wires.

Third, broken telephone wires have done harm by coming in contact with electric light wires having defective insulation. Then, as far as possible, the route of telephone lines should be so planned as to avoid all alternating-current lines, owing to the inductive disturbances created by the latter. Moreover, the degree of danger may be greater where the installation is defective on alternating-current lines than where a low-potential system is employed for lighting and power purposes, should a telephone wire come in contact with the broken insulation on a wet day. And, even though alternating currents may not be employed in local lighting when the telephone pole lines are planned, it is wiser to avoid all electric light lines, as there is no telling how soon the alternating-current system may be adopted by the local lighting company. Where the streets are wide, the inductive influence of an alternating current may be so slight as to be inappreciable in a telephone circuit carried along the opposite side of the street. But in narrow streets inductive troubles may be expected unless telephone lines of twisted pairs are used, no matter how perfect the insulation is on the alternating-current circuits. Any increase or decrease of current in the alternating-current conductors will be readily noticeable in the telephone lines.

Fourth, trees are disturbing factors in the locating of telephone pole lines. In damp weather, and occasionally even in dry weather, a portion of a tree limb or branch touching the bare telephone wire often serves as a conductor to form a ground, which may give a wrong signal at the exchange, or throw the line out of balance, or do some other mischief. Hence, when the wire circuits must be carried between the branches of a number of trees, the wire should be insulated or the branches trimmed as closely as permissible in order to keep the lines clear at all times. It is preferable to cut the branches close to the trunk and paint the cut surface with white lead. Where the lines pass just over the trees, the upper portion of the highest branches should be periodically trimmed. If the owner absolutely refuses to allow his trees to be suitably trimmed, the wire circuits must be insulated, or an aerial cable employed, if satisfactory service is expected.

However, it should be borne in mind that all insulation is subject to abrasion where circuits pass between tree branches, owing to the wind swaying the branches to and fro over the insulation. Hence, in approved telephone engineering practice the cables are wound with iron wire which serves as an armor. This armor wire affords sufficient protection when wound crosswise, or rather in two spirals wound oppositely the pitch of each spiral being about 6 or 8 ins. For ordinary service a No. 12 or No. 14 iron wire is employed for this purpose, though almost any steel or iron line wire is suitable, even though second-hand. The methods adopted for supporting the cable will be described later on.

There is one point to carefully bear in mind in erecting a pole line in alleys, and especially in narrow alleys. Make it the rule to always use as large cross-arms as can be put on the pole, if for no other reason than to secure and hold the right of way for the full space that the largest mechanically-possible cross-arm requires. If a smaller arm is adopted for alley pole lines at first, later, when the subscribers' lines have grown so numerous that longer cross-arms must replace the shorter ones first adopted, serious objections may be raised by the property owners as to the right of the telephone company to take the second and wider right of way covered by the larger cross-arms. Usually such cases develop so much delay and such strong and bitter feeling, that it has been found more economical to use the larger and more costly cross-arm in the beginning, even though only one subscriber's line be carried at first. Where the standard 10-pin cross-arms cannot be placed on alley poles in the ordinary manner, owing to the proximity of walls or buildings, so-called alley arms may be used.

In this connection it may be mentioned that the latest engineering practice is to use 10-pin cross-arms, even for country lines, and to clear the right of way on each side as wide as the most extreme circumstances will allow, in the beginning, to avoid disputes that might arise in the future. It is well to bear in mind when locating country lines that close proximity to telegraph lines should be avoided as far as possible owing to the click of the telegraph instruments being so clearly repeated over the telephone lines as to seriously interfere with conversation.

When choosing a route for a pole line, always keep in mind the previous statement, that the greater the number of subscribers' lines that can be concentrated in one line, either in open wires or in cables, the lower will be the cost per subscriber for installation and for maintenance. Thus, present experience shows that the most satisfactory plan for laying out a telephone exchange is to have two main pole lines run at right angles to each other and parallel to the streets, so that the office will be located in the intersection, as shown in Fig. 1, where *O* is the office; *A—B* one main pole line, and *C—D* the other. Then the lines of all subscribers located within the area embraced in the angle *A O E*, should be brought to the main pole line *A—O* by the most direct route, while all lines from subscribers located in the angle *E O C*, should be brought down to the main pole line *C—O* in as straight a line as possible. To this pole line *C—O*, are carried also the lines within the angle *F O C*, while lines within the angle *F O B* are carried to the pole line *B—O*, as shown by the arrows, and so on.

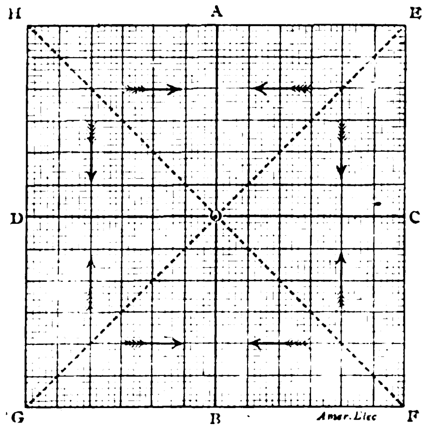

FIG. I.

To sum up the foregoing suggestions, poles should be located so as to make the line not only firm and safe against the influence of heavy winds and inclement weather, but also so it will be as inconspicuous as possible. Local conditions greatly influence the proper location of poles. Poles should not be further apart than 150 feet, and wherever possible, should be located on the corners of streets, the corners of alleys, and the dividing lines of adjacent properties. If one pole line is already on the street, endeavor to locate on the side of the street that is free from poles. Where each side is occupied by one or more pole lines, locate each pole in the new line at least ten feet from the nearest pole in the line or lines already occupying the street, and at points where the new lines will not interfere with the old lines. Avoid paralleling electric light or street railway lines, for reasons already given. Be careful that the poles are so located, especially in alleys, that the wires when strung will clear all private property. Avoid streets having heavy foliage, if possible; otherwise, trim the branches as closely as permitted, or cable the wires and get the poles closer together. Avoid crossing steam railroad tracks, as the fumes from the smokestacks of the locomotives are apt to corrode the wires.

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PIPING MATERIALS FOR STEAM PLANTS

BY JOHN B. BERRYMAN.

Designing a system of steam piping is properly the province of the professional mechanical engineer. The manufacturer is interested in the design only so far as it may adversely affect his product. He has, however, a vital interest in the quality and type of the materials specified, as in the event of failure of any part of the system he usually bears the lion's share of the blame.

It is obvious that the manufacturer of any article whatever should have a knowledge of service conditions if he is to attempt to fulfil such conditions satisfactorily. Having such knowledge, it becomes necessary, when designing valves, fittings, or other steam appliances, to draw upon the usual sources of engineering information as to strength of material, etc., supplementing this by a broad series of shop tests to determine whether the theoretical information is borne out by facts. The Crane Company has carried on a series of such tests for several years, principally covering the field of high pressure steam piping, and the results of these are given briefly herein.

PIPE.

Ordinary commercial pipe, 12-in. and smaller, appears to have an ultimate bursting strength in excess of 1500 lbs. per sq. in., provided the weld is perfect. Some lengths of 10-in. pipe, taken at random out of stock, have been tested to 2300 lbs. per sp. in.; 8-in. to 2000 lbs.; 12-in. to 1500 lbs.; 16-in. (⅜ thick) to 800 lbs. and 24-in. (⅗ thick) to 600 lbs.; all without rupture or apparent distortion. From time to time, thousands of pieces of all sizes from 20-in. down have been tested under 800 lbs. per sq. in., so that as far as strength is concerned, there appears to be no reason why pipe heavier than standard should be used on power plant work. In plants where the feed water is bad, it is economy to run the feed lines of extra strong pipe, and this has become quite a common practice even where the water is comparatively good.

FLANGED JOINTS.

Considering everything—first cost, ease with which a line can be altered or repaired, freedom from troublesome leaks and strength against tensile strain—we think a good screwed joint is superior to any other. We use two lengths of threads, the standard up to 125 lbs. and a somewhat longer full taper thread for pressures up to 250. They compare as follows:

	Standard.	Extra Long.
4-in. length	1-3/16 ins.	1-¾ ins.
6-in. length	1-7/16 ins.	2 ins.
8-in. length	1-⅝ ins.	2-1/16 ins.
12-in. length	2-1/16 ins.	2-9/16 ins.
16-in. length	2-7/16 ins.	2-⅞ ins.
20-in. length	2-¾ ins.	3-¼ ins.

To determine the holding power of threads we made a large number of tests commencing with the long threads and gradually cutting them away. Results showed that the strength of the joint was limited by the strength of the cast iron flange. In no case was the thread stripped. On a 10-in. pipe the threads were reduced until barely five threads were in contact instead of 14, as called for by our standard tables. On the test the flanges broke at 650 lbs. per sq. in., all threads being intact. This question of the holding power of threads is one that we frequently have to explain, as some people are under the impression that under high pressure the threads are likely to strip. A calculation of the amount of metal, which would have to be sheared off before the joint parted, will effectually still any fears in this direction. Taking for example our standard length of thread, 8 threads per inch, the result works out as follows:

Size.	Length of threads.	Metal in contact. Sq. ins.	Sectional area of full weight pipe.
8-in.	1-⅝ ins.	42	8.396
12-in.	2-1/16 ins.	77	14.579
16-in. (⅜)	2-7/16 ins.	116	18.41

If we assume that the shearing strength is one-half of the tensile, then it is evident that the holding power of the threads is fully three times greater than the ultimate strength of the pipe. Mr. R. T. Crane had a great number of tests made upon runs of 8-in. pipe using regular wrought iron couplings, for the purpose of demonstrating that long threads were not essential to strength. The final test was made with threads only ¾ in. long, barely 6 threads being in contact. The pipe was tested to 1000 lbs per sq. in.; the pressure being held on the line for a day.

The object in making threaded joints for high pressure work longer than standard, is not to gain greater tensile strength, but to reinforce the pipe by a deep hub and by throwing a large number of threads into contact to guard against the flanges being loosened by the continual vibration of a high pressure line.

It is important to have the pipe screwed completely through the flange, first to guard against the vibration, and secondly to make a bearing for the gasket upon the end of the pipe and to close the thread against the oxidizing action of the steam.

It is our practice to screw the flange on with power, until the ends of the pipe project about 1/16 in. The piece of pipe is then swung in a special lathe and the projecting ends cut off, a light cut being then taken on the face of each flange to insure them being parallel and at right angles to the true longitudinal axis of the pipe. This refacing operation is absolutely essential to a first-class job. Pipe is rarely perfectly straight, and even if it were, there is the chance of the thread on the pipe, or in the flange, being cut on a slight angle, which in a long run might throw the line out considerably, or in a run with a number of joints the multiplication of a very small error in each one, will aggregate a large one. Each pipe should drop into place naturally without undue strain upon the flanges, and this can only be accomplished by the refacing method.

The shrunk joint is made in the following manner: The pipe is rounded up and calipered; the flange is then bored out to a shrinking fit and after being brought to a red heat, is slipped over the pipe and the end of the pipe peined over. The flanges are then turned up in a lathe, as before described. It is claimed for this joint that the full thickness of the pipe is carried through to the face and consequently it will stand more pressure and have a longer life than the screwed joint. The experiments we have made do not bear out this view. It is certain that against tensile strain the screwed joint will hold all the pressure that can be put on it; in fact with end and blind flanges sufficiently strong a pipe may be burst under pressure without injuring the threads, while against lateral strain, expansion or vibration, a screwed joint properly made, is, if anything, better. The chief objection to a shrunk joint is its high cost and the fact that a gasket must cover the end of pipe in order to make a tight joint. There are very few joints of this kind, whether they are shrunk on hot or peined on cold, which will not leak if the end of the pipe is exposed.

Cast iron flanges riveted on are very undesirable, as they almost invariably leak through the rivet holes when subjected to the vibration of a steam line in active service.

FLANGE FACES.

For pressure of 180 lbs. or less, our experiments go to show that a straight concentrically corrugated face will hold a Rainbow or copper gasket without trouble. We have made repeated tests with pressures up to 1000 lbs. without blowing out the gasket. There is no manufacturing objection to male and female facing other than increased first cost, and the fact that such goods are not carried in stock and there is always a delay in filling orders, but operating engineers have frequently complained to us about the difficulty they experience in changing gaskets, if for any reason it is necessary to break in on the line. It is a severe task to spring a large heavy pressure line apart sufficiently wide to permit of removing the old gasket and putting in a new one.

FLANGED FITTINGS.

We manufacture these fittings in three weights. The lightest for very low pressures, such as exhaust or condenser connections; the second for standard pressures up to 125 lbs. and the heaviest for high pressure lines up to 250 lbs. per sq. in. The thickness of body metal in the three styles is as follows:

	Light.	Standard.	Extra heavy.
6-ins.	....	9/16-in.	¾-in.
10-ins.	....	¾-in.	15/16-in.
12-ins.	½-in.	13/16-in.	1-in.
16-ins.	⅝-in.	1-in.	1-3/16-in.
20-ins.	11/16-in.	1 ⅛-in.	1-5/16-in.
24-ins.	¾-in.	1-¼-in.	1-½-in.
30-ins.	⅞-in.	1-½-in.	....
36-ins.	1-in.	1-¾-in.	....

Applying to these fittings the well-known formula for cast iron pipe,

$$P = \frac{2T}{D} \times \frac{S}{5},$$

in which P=pressure; T=thickness of metal; D=diameter; S=tensile strength, and 5 is a factor of safety. It will be seen that we have largely increased the factor of safety to cover possible defects in the metal, core shifts, or other imperfections. For example: in the case of a 16-in. extra heavy fitting to carry 250 lbs. working pressure, we have 1-3/16-in. metal with a tensile strength of 20,000 lbs.; then the factor of safety is 11.80. In a 12-in. extra heavy fitting it is 13.33, and in a 24-in. extra heavy fitting, 10.

VALVES.

In valves the call is now for straightway type. A number of angle valves are still used on boiler or engine leads, but a globe valve on a plant of any magnitude is very exceptional. They are still used freely on small lines and wherever it is necessary to throttle the steam. Beyond this the gate valve has so many advantages that it has practically secured the market.

To cover the range of power plant work we have had to build four lines:

(1) Low pressure for exhaust and condensing lines.
(2) Standard for pressure not exceeding 125 lbs.
(3) Medium for pressure not exceeding 150 lbs.
(4) Extra heavy for pressure not exceeding 250 lbs.

Upon the low pressure line we have not made very extensive tests, further than to ascertain that the valves are tight at 50 lbs. per sq. in. The other lines have been thoroughly tested out on all except the very largest sizes. Boiling down the results and striking general averages we arrive at the following: Standard valves 4-in. to 8-in. will burst at about 700 lbs., and 10-in. to 16-in. will burst at about 600 lbs. The larger sizes we have not burst, but have tested the 18-in. to 450 lbs. and 20-in. to 30-in. up to 300 lbs. pressure without injury. The medium valves will withstand a pressure of about 500 lbs. in excess of the standard. Extra heavy valves 4-in. to 8-in. burst at 1600 to 1900 lbs., and 10-in. to 16-in. burst at 1200 to 1500 lbs. The larger sizes have not been destroyed, but the 18-in. has been subjected to 850 lbs. and the 20-in. and 24-in. to 600 lbs. without injury.

The next point to ascertain was the maximum load which could be applied to the discs without causing a leak. This load was found to be in nearly all cases 80 per cent. of the ultimate strength of the body. All pressure valves mentioned here were of the solid wedge type. It is not possible to obtain equivalent results from parallel-seated, double-disc valves, for the reason that the latter have two comparatively light faces set out by an internal wedging mechanism and the face exposed to pressure will spring under a load very much less than can be sustained by a solid wedge.

It has been the custom for many years to rib the bodies of high pressure valves. The ribs give a massive appearance and are desirable on that account from the standpoint of the selling department, but they serve no good purpose mechanically and are a detriment instead of an advantage. The distribution of metal is so uneven that shrinkage strains are set up all along the corners where the ribs join the body, making the metal porous. A ribbed valve will not stand any more pressure than one with a plain body, and the only point which might be argued in favor of the ribs would be that they stiffen the valve against strains due to settling in the line. It is not, however, very logical to guard against a remote possibility by setting up a number of internal strains, especially where a plain bodied valve can be designed which will take care of all strains reasonably to be anticipated. We have concluded to abandon the ribs altogether and shall hereafter only make valves of that style on special orders.

For high pressure work we always recommend valves having outside screw and yoke, stationary wheel and rising spindle, in fact for any service this type is preferable, except on the very large sizes where the great height from top of spindle when open, to the bottom of the valve, is a serious objection. The advantages over the internal screw valves are:

(1) The stem is an indicator showing at all times the position of the disc.

(2) The thread on the stem is never in contact with the steam and can be properly lubricated.

(3) There is no thread in the wedge.

By-passes should be used on valves 8-in. and larger when high steam pressure is used. The load on the wedge of an 8-in. valve at 180 lbs pressure is 9047 lbs. and on a 16-in. valve 36,190 lbs. It is obvious that under such loading the pressure must be partially equalized on each side of the wedge before the valve can be opened with facility.

PIPE BENDS.

Bends are used very freely. By their use all expansion strain can be taken up and the number of joints materially reduced. In the process of bending the outer circumferential wall of the pipe is stretched, as the inner wall will not compress to any extent without buckling. There is also an appreciable loss of metal through scaling. Unless the bends are of very short radius they are generally made of standard pipe for pressure of 125 lbs. or less, full weight pipe up to 175 lbs., and extra heavy pipe for higher pressures. If the bends are used to take up expansion it is well to make them of pipe as light as is consistent with safety. The shape of the bends will determine generally the material which ought to be employed, as in those with large radius the stretching of the metal may be almost disregarded.

In conclusion we strongly advocate the use of staple, catalogued goods wherever possible. Such a variety of fittings and valves may be obtained now from stock that there does not seem to be any necessity for the enormous number of specials which we, in common with other establishments in our line, are daily called upon to make. Many times these specials serve no other purpose than to put into concrete form some whim or fad of the engineer in charge of the installation.

Specials are often the product of theory only. Staples result from theory and experience. A purchaser who buys a staple article from a reputable house, has the assurance that such an article has been thoroughly tried out, possibly hundreds or thousands of times, under conditions similar to his own. In addition he can get reasonably prompt shipment and the benefit of a lower price due to special machinery and the elimination of pattern labor.

[The foregoing is a paper read at the last meeting of the Engine Builders' Association of the United States. Mr. Berryman is the head of the Crane Company's Engineering Department.]

Electrical Equipment of the C. & C. Shaft of the Consolidated California & Virginia Mining Company.

BY LEON M. HALL.

When the mining properties on the Comstock Lode were first developed, operations were carried on by means of steam generated power, wood being used as the fuel. This was very costly on account of the scarcity of wood. The milling was, until quite recently, done at a distance of some 15 miles from the mine, at a point on the Carson River, where cheap water power could be obtained. About two years ago the question of electrical transmission for the purpose of supplying power for deep mining operations on the Comstock Lode was taken up, and since then, extensive hydraulic developments have been carried out at Floriston, Cal., on the Truckee River. Power is now transmitted 35 miles to the mines in Stotey County, and a dozen or more of the properties have been equipped with electrical machinery. Among these is the C. & C. shaft of the Consolidated California & Virginia Mining Company, which has a world-wide reputation as a bullion producer.

The power plant on the Truckee River is about two miles east of Floriston. The river is dammed just below the Floriston Pulp & Paper Mill, and the water is conveyed about 600 ft. through a canal and then 8,600 ft. through a wooden flume 6 ft. 8 ins. high and 10 ft. wide, to a point directly above the generating station. It is then conducted through two wooden stave pipes 160 ft. long and 6 ft. in diameter to the wheels, upon which there is a head of 84½ ft. There are two pairs of 27-inch horizontal McCormick turbines, direct connected to Westinghouse, three-phase, 60-cycle generators of the revolving armature type. These generators are separatly excited by two 22½-kw. direct-current machines. The wheels will each develop 1,400 horse-power at 400 r.p.m., with the above head of water. They are regulated by two type "B" Lombard governors. Current is generated at 500 volts and is raised to 24,000 volts by means of six 300-kw. Westinghouse oil-insulated transformers, at which potential it is transmitted 33 miles over a double circuit of No. 4 hard-drawn copper wire, to the

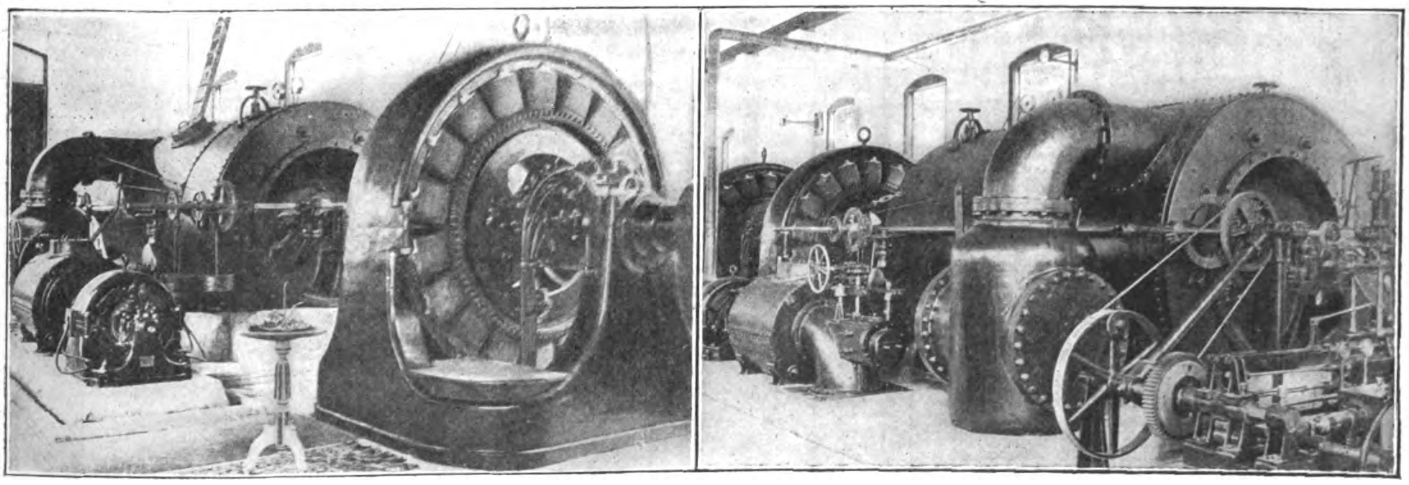

FIG. 1.—THREE-PHASE GENERATORS COUPLED DIRECTLY TO WATER-WHEELS IN THE FLORISTON POWER HOUSE ON THE TRUCKEE RIVER.—FIG. 2.

sub-station at Virginia City. The line is composed of square redwood poles 30 feet in length, with pine cross arms and locust pins, upon which are mounted 7½-in. Locke insulators. The telephone circuit is carried on the same poles by oak brackets with pony insulators. At the sub-station at Virginia City, the potential is lowered to 2,300 volts by means of six 450-kw. Westinghouse oil-insulated transformers, and at this potential current is distributed to the various mining companies. The distribution circuits are composed of weather-proof wire, and are designed for 4 per cent. drop under full load.

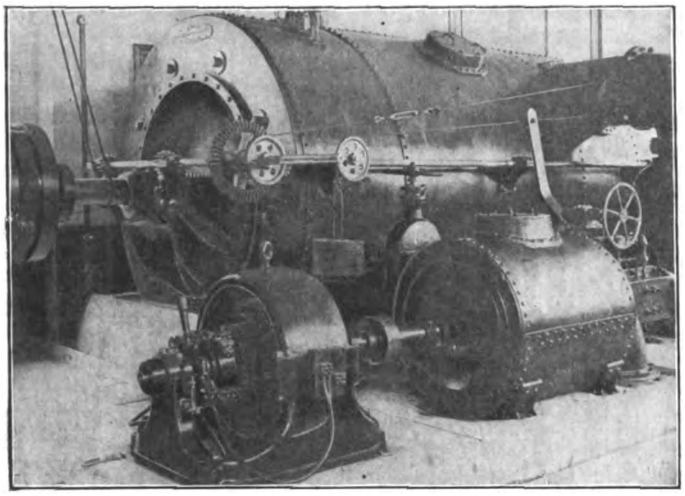

FIG. 3.—EXCITER AND ITS DRIVING TURBINE.

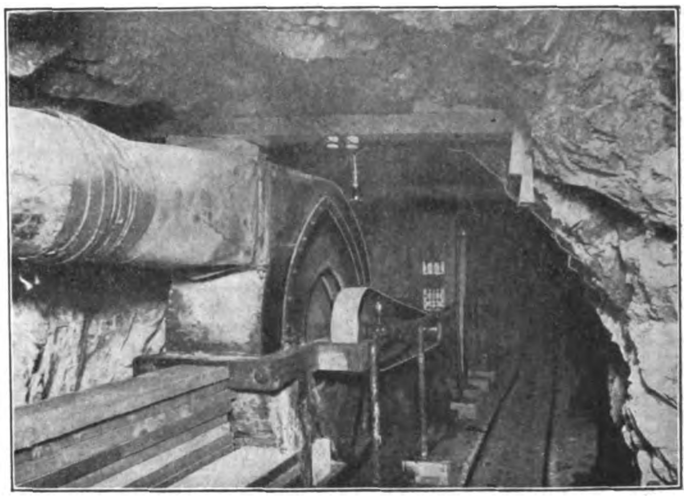

FIG. 5.—MOTOR-DRIVEN BLOWER AT 2,150 FOOT LEVEL.

The Truckee River General Electric Company sells power to the various mining companies at $7 per horse-power per month, the amount used being based on a maximum peak load of two minutes duration. This, with other conditions, has made advisable the installation of machinery of the very highest grade and the introduction of some features which are rather unique in character. In the C. & C. shaft at Virginia City every precaution has been taken to secure thorough reliability and the highest efficiency. The electrical machinery in operation on the surface consists as follows:

A 200-h.p., type "F," 2200-volt, variable speed, three-phase, Westinghouse induction motor, geared to a balanced electric hoist; a 100-h.p., type "C," 2200-volt, Westinghouse induction motor, belted to a 16½-in. by 30-in., single stage air compressor; a 30-h.p., type "C," 440-volt, Westinghouse induction motor, operating circular saws; a 15-h.p. motor of the same type, driving tools in the machine shop; a 10-h.p. motor of the same type, operating a Blake rock breaker at the ore bin; three 15-kw., indoor type, Westinghouse transformers, transforming from 2200 volts to 440 volts; one 5-kw., Westinghouse lighting transformer, transforming from 2200 volts to 110 volts; 50 incandescent lamps, together with necessary lightning arresters, fuse blocks, cut-outs and switches.

The apparatus underground consists of the following:

A 15-h.p., type "C," induction motor, operating at 440 volts and driving a fan on the 250-ft. level; two 10-h.p. motors of the same type, driving fans on the 1950-ft. and 2150-ft. levels; three 225-h.p., type "C," motors, operating at 2200 volts, and geared to three duplex double-acting Reidler pumps, located on the 2150-ft. level; three 10-kw., type O. D. transformers, transforming from 2200 to 440 volts, located on the 1750-ft. level; a 3-kw. lighting transformer, transforming from 2200 volts to 110-volts, on the same level; three 15-kw., type O. D. transformers, transforming to 440 volts, on the 1950-ft. level; two 15-kw., O. D. lighting transformers, transforming from 2200 volts to 110 volts, on the same level; three 10-kw. transformers, transforming to 440 volts, on the same level; a 5-kw. lighting transformer, transforming to 110 volts, on the same level. These transformers supply the motor and lighting circuits within the mine.

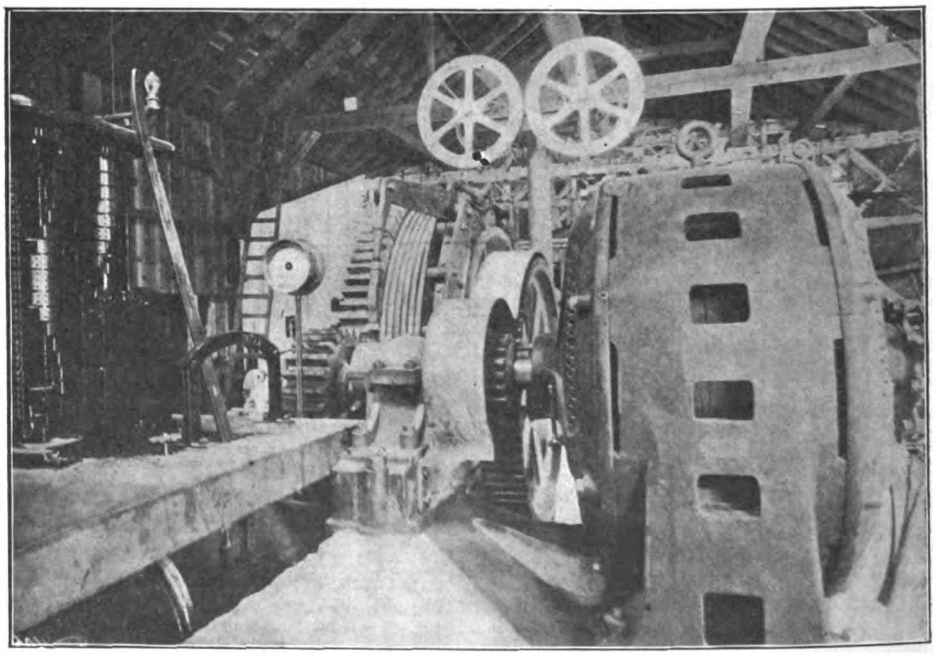

FIG. 4.—CONTINUOUS ROPE HOIST DRIVEN BY A 200-H.P. INDUCTION MOTOR.

There are 250 16-c.p. incandescent lamps scattered through the workings underground. A No. 6 B. & S. 3-conductor lead covered cable armored with iron wire extends from the surface to the 2150-ft. level, and a No. 0 3-conductor cable to the pumps on the same level. The cables were lowered down the shaft by means of the hoisting rope, and then securely clamped to the wall plates. At each station a water-tight junction box is used, and the lead covering sweated into a tight-fitting sleeve located in the side of the box.

The power is brought into the works over two separate circuits, each of which is provided with a single-pole switch at the entrance of the building, and also a Westinghouse integrating wattmeter with its transformer. The pump circuit is further equipped with an ammeter, a frequency indicator, a power-factor indicator and a static ground detector. Oil-break switches are used on the cable circuits and upon all of the 2200-volt motors. The smaller motors, both on the surface and underground are equipped with auto-starters, quick break switches and slate base fuse blocks. Some of these machines are located in warm places and operate under severe conditions.

The entire installation is wired with lead covered cables or with rubber-covered copper wire mounted on glass insulators or porcelain knobs. Candles have been entirely discarded, incandescent circuits having been carried directly to the working faces and into the stopes. The current is taken into the mine at a potential of 2200 volts, through the cables above mentioned, and the potential is lowered in the mine by transformers, which are located as near as possible to the point of consumption.

The compressed air plant, supplying air for drilling, a number of underground hoists and the hydraulic pump, consists of a 16½ x 30-in. Rand & Waring single-stage air compressor, driven at 73 r.p.m. by a 100-h.p., type "C," Westinghouse motor. The motor speed is 580 r.p.m., which is reduced by a countershaft with wooden rim pulleys and rubber belting. No automatic regulator is used at the present time, as the compressor is working to its full capacity and the motor is developing 96 horse-power.

The electric hoist is a decided departure from usual practice in deep mine hoisting plants, and embodies what is commonly known as the balanced, continuous or tail-rope system. This was adopted in order to reduce the cost of operation and also the size of the motor to the lowest size compatible with the duty required, viz., to hoist 500 tons daily from the 2500-ft. level by means of double-deck cages carrying 3600 pounds of rock. The hoist consists essentially of a main driving drum and an idler, around which is wrapped a 1⅛-in. plow steel wire rope. The rope passes down one compartment, around a movable tail sheave and up the other. One cage is inserted between the ends of the rope and the other fastened to it by means of heavy iron clamps.

The main driving drum is geared to a 200-h.p., type "F," variable speed Westinghouse, three-phase induction motor, which operates at a maximum speed of 580 r.p.m., moving the cages through the shaft at 1250 feet per minute. The speed of the motor is controlled by means of variable resistances inserted in the rotor winding, but external to the motor itself. The variation of the resistance is accomplished by the use of a special controller resembling an ordinary street car controller; the primary circuit is controlled by means of an oil-break switch. The hoist is equipped with heavy post brakes, hydraulically operated, and the machine is handled with remarkable ease. In tests that have been made these hoists show a net efficiency of about 75 per cent., counting all electrical and frictional losses.

The pumping plant consists of three duplex double-acting 6 11-16 x 24-in. Riedler pumping engines, located on the 2150-ft. level. These pumps take their water supply from a tank on the east side of the shaft just below the 2150-ft. station. Each pump is separately driven by a 220-h.p., type "C," 2200-volt, induction motor, and has a capacity, at 110 r.p.m., of 1500 gallons per minute to the height of 450 feet, or to the Sutro Tunnel level. The motors run at a speed of 495 r.p.m., the necessary reduction being obtained by the use of cut gearing with stepped teeth. The total capacity is 4500 gallons per minute, and is intended to take the water from the hydraulic elevator as long as it is used as a sinking pump.

The pumps are located in a station 30 feet north of the shaft. This station is cut from the solid rock, and is 18 ft. x 17 ft. 8 ins. in section and 110 ft. long. It is timbered with 14-in. x 14-in. pine timbers, with 3-in. planking. A drift 5 ft. x 10 ft. 6 ins. in section connects it with the shaft, and ventilation is obtained by means of a small electrically driven blower. The motors are all wired with lead-covered cable, and the station is lighted with incandescent lamps. A 10-ton hand crane travels the entire length of the station, so that the labor of handling and installing machinery has been reduced to a minimum.

This plant is one of the most complete mining installations in the world, and its operation has been entirely satisfactory, both in regard to economy and reliability. Up to the time when electrically-transmitted power was adopted, the cost of motive power was never less than $20 per horse-power per month, while under existing conditions it is reduced to $7. For example, the cost of operating the 100-h.p. air compressor usually averaged about $1,800 per month, while to-day it is only $672. The entire plant was installed according to the writer's plans and specifications, and under the able direction of Superintendent Joseph R. Ryan.

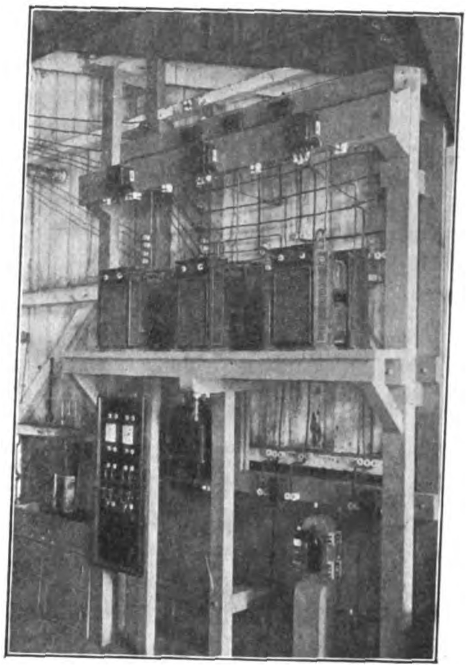

FIG. 6.—TRANSFORMERS FOR SMALL MOTORS.

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Polyphase Motors on Single-Phase Circuits.—In Mr. McAllister's article on this subject, which appeared in the August number of the AMERICAN ELECTRICIAN, the statement near the bottom of the third column on page 385: "Under this condition the displacement (when no current is being taken off at P) will be SE_{T}. or one-half the line voltage," should read: "Under this condition the displacement (when no current is being taken off at P) will be $.5E_{\text{T}}$. or one-half the line voltage." As will be obvious from this correction, the coefficient ".5" was misread "*S*"; the definition of S which was inserted immediately after was taken from the preceding article.

CENTRAL STATION DEPRECIATION.

Among the many subjects discussed informally at the Cincinnati convention of the National Electric Light Association was that of central station depreciation. This discussion, although very interesting, brought out such a diversity of opinion that it is impossible to deduce any definite rules or recommendations that can be regarded as "approved" even by a majority of representative central station men. Mr. W. L. Abbott, of the Chicago Edison Company, expressed the opinion that electrical apparatus depreciates much faster than we realize, if it is considered that besides wearing out the chances of apparatus becoming obsolete must be taken into account. Apparatus that has been used in the business for the last 15 years has not had an average life of over 6 or 8 years. Mr. Abbott said he found in making an estimate for depreciation, his figures are always higher than those of anybody else, which perhaps is because he has been in the business longer than most other people who figure on depreciation. While depreciation is not so rapid now as in the past, it should not be taken at less than 15 or 20 per cent. during the first few years; after that the depreciation will be correspondingly less.

Mr. I. B. Smith, of Cedar Rapids, Ia., said that depreciation will vary from 2 per cent. up to 10 per cent. for different classes of apparatus, depending on what the apparatus is. On the power house many companies consider that 2 per cent. is a fair depreciation. A point to be considered also aside from actual wear and tear is that apparatus may either decrease or enhance in value. The last few years has actually shown an increase in the value of some electrical apparatus, whether it is old or new. To adopt any particular system will give rise to complicated problems, and it may be better to guess at it and see how one comes out.

Mr. James B. Cahoon, of New York, took issue with Mr. Abbott on the question of making the depreciation 15 per cent. for the first five years of the use of electrical apparatus. While this was perfectly true of electrical apparatus in the past, it is not true of the electrical apparatus sold to-day. The question of depreciation is a new one, comparatively speaking. It has been the custom of many companies in the years gone by to let depreciation look after itself, and they have run along declaring dividends when they could, and all at once had to meet the issue that their apparatus was obsolete, or had gone to pieces and had to be replaced, with no depreciation fund to cover this expense. The English method of setting aside a definite amount for depreciation, and placing that at interest, is better than any of the methods adopted in this country. Some engineers here have advocated shaving off 5 per cent. on certain pieces of apparatus and carrying it along at 5 per cent. for the whole period of its life. Then certain engineers have recommended that if we set aside 5 per cent. for depreciation, this should not be put into a bank, but considered a fund against which should be charged improvements and betterments, so that the value of the plant shall remain the same at all times; in other words, thus keep the plant up to the same general level of efficiency as in the first place, or keep the plant always at 100 per cent. That is to say, instead of charging improvements and betterments to the construction account, they are charged against this depreciation fund.

Mr. Cahoon considered that the best plan would be to take each piece of apparatus of to-day, estimate its life and, therefore, rate of depreciation; then set aside annually, say at 3 per cent., an amount which at that rate of interest will equal the original cost of the apparatus. If this plan were carried through for each class of apparatus, engines, boilers, dynamos, buildings, lamps, lines, etc., etc., a pretty fair estimate would be arrived at as to the depreciation.

Mr. Abbott said that to further illustrate his previous remarks, suppose the case is taken of a new direct-connected unit costing $100,000—a generator connected to reciprocating engine. The next year we may find that we can get a unit of the same output as economical as the reciprocating engine, in a turbine unit, for, say, $70,000. It would then be quite proper at once to write off $30,000 for depreciation, or 20 per cent. After that, depreciation would not be so rapid.

Mr. Arthur Williams, of the New York Edison Company, said that many engineers allow nothing for depreciation on the ground that repairs and renewals offset the depreciation. But in an isolated plant you must charge off depreciation either through several years or in the last year, and it is important to have an established rule. This question was brought up at the meeting of the American Institute of Electrical Engineers at Boston in 1899, and the general feeling was that 10 per cent. on the cost of any electrical plant was a fair depreciation charge annually. Nothing was said as to whether it should be at single interest or compound interest. The New York Edison Company's charge is 8 per cent., which represents 12 years of life, the depreciation coming about in several ways—through the wearing out of machinery, or its profitable replacement by other forms of machinery, and also by the limitation of the useful life of the machinery due to greater competition of the central station companies; this competition increasing by lower manufacturing costs on the one hand, and the increase in efficiency of translating devices, such as the Nernst lamp, or the substitution of arc lights for incandescent lights, on the other hand.

Mr. Leonard Andrews, of Hastings, England, said that this is a question which has been discussed in England for some time. There is in Great Britain an association of municipal electrical engineers, the managers of municipal stations; and during the last few months they have been discussing this question of depreciation pretty fully. But a short time ago at a meeting of practically all the members of the association, it was almost unanimously agreed that if about 3 per cent. per annum were set aside for depreciation, that would be sufficient. Of course, the depreciation is not at same rate as here, as plants are not scrapped quite so quickly.

Mr. Charles R. Price, of New Bedford, Mass., agreed with Mr. Williams that when it comes to the substitution of incandescent arcs for the old open arc, it practically results in scrapping machines which cost several thousand dollars, and, therefore, 10 or 15 per cent. is a safe depreciation charge per annum.

In reply to a question, Mr. Cahoon said that if a company takes the betterments ordinarily put into a plant from year to year, and instead of charging them up to construction account, charges them to maintenance and operation, it is for all practical purposes maintaining the plant at 100 per cent. Referring to Mr. Abbott's statement in regard to charging off on a $100,000 plant $30,000 because some turbine comes up to replace the ordinary reciprocating engine, Mr. Cahoon said he did not think that is doing justice to the plant. The difference in efficiency between the steam turbine, so far as we know at the present time, and a first-class reciprocating engine, is not great enough to warrant that amount being charged off. No plant can stand such a heavy charge being made against it any one year. If it is thought desirable to charge it off, it should be charged to expense account and distributed over five years; otherwise dividends are deferred, stockholders will make objection, and a small plant cannot stand such a system.

Mr. Harry Bottomley, of Bellows Falls, Vt., said that the Gas and Electric Light Commission of Massachusetts when estimating in their annual returns the cost of lighting in municipal plants, add in as a factor of the cost of the lighting the sum of 5 per cent. on the total capital invested as a depreciation fund.

Mr. D. F. McGee asked whether on the basis of 10 per cent. depreciation, and a plant worth $100,000 when it is installed, if improvements are made to the amount of $5,000, the value of the plant at the end of the first year should be $90,000, and if 10 per cent. should be written off from that amount the following year. In reply Mr. Arthur Williams said that if the plant cost $100,000, and during the first year $5,000 in improvements were made, then the total cost of the plant is $105,000, and at the end of the first year 10 per cent. on $105,000 should be written off.

A motion was made to the effect that it is proper to charge off to depreciation 10 per cent. annually on electrical and mechanical equipment, and a similar motion was made placing the percentage at 7½ per cent. Some opposition having developed, the matter was referred to a committee for report.

Subsequently, in answer to a question as to whether a distinction should be made between boiler and engine room, or whether they should be classed as a whole, President Doherty said he thought they should be distinct; that every piece of apparatus should be distinct. There are no two classes of apparatus that will depreciate at the same rate, nor are there any two makes of apparatus that will depreciate at the same rate.

Abstracts from Foreign Contemporaries

The Partridge "Sparklet" Fuse.——G. W. Partridge, chief engineer of the London Electric Supply Corporation, has made an ingenious use of a little capsule of liquid carbonic acid, known to readers of street-car advertising as a "sparklet" and used for the manufacture of soda water at home, for breaking a 10,000-volt spark between contacts one-half inch apart. The "sparklet," as is well known, is a small steel capsule containing liquid carbonic acid under considerable pressure and sealed by a steel cap and rubber ring, held in place by the edge of the main part of the capsule being turned over. In the fuse the sparklet is so placed that if the arc continues the cap of the sparklet is melted off and the carbonic acid gas, escaping under pressure, effectually blows out the arc. Fig. 1, taken from the London *Electrician*, is a sectional elevation and plan showing the details of its construction. The fuse wire is laid on a mica strip in an earthenware trough and to within one-half inch of the edge is covered with a second strip of mica, the two mica strips being held together by a paper fastener. The fuse, which is about nine inches long for a 10,000-volt arc, is clamped between contacts in the usual manner and a sparklet fits through a hole in the porcelain screen at each end, as shown in the illustration. The solid end of the sparklet behind the screen makes contact with the terminal of the fuse by means of a spring contact, but the other end of the sparklet, containing the cap, is above the uncovered part of the fuse wire, so that it does not form a part of the main circuit until the arc rises from the fuse. The heat of the arc melts off the caps of the sparklets and the jet of carbonic acid blows out the arc.

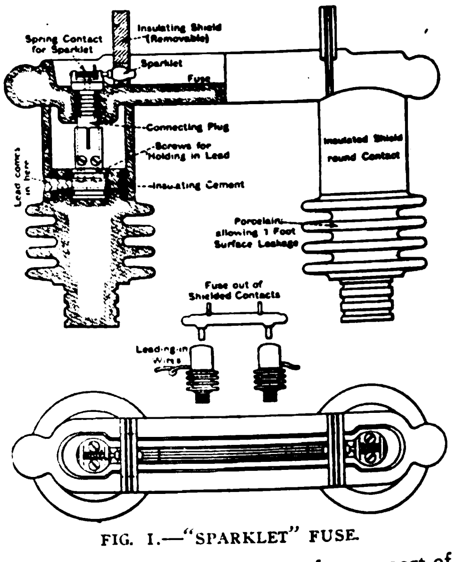
Spring Contact for Sparklet
Insulating Shield (Removable)
Sparklet
Fuse
Connecting Plug
Screws for Holding in Lead
Lead comes in here
Insulating Cement
Insulated Shield round Contact
Porcelain allowing 1 Foot Surface Leakage
Fuse out of Shielded Contacts
Leading-in Wires

FIG. I.—"SPARKLET" FUSE.

New Surface Contact System.— *Le Genie Civil* describes the surface contact system invented by M. Cruvellier, which possesses some novel features. In many of the surface contact systems at present in use, the rails are used for return circuits; but in the system under discussion the rails play no part, contact studs being automatically made positive and negative, and two skates or runners collect the current, instead of one. A general idea of the arrangements may be obtained by the diagrammatic sketch shown in Fig. 2. It will be noticed that there are two main cables and that connections are run from each of these to each of the contact stud boxes marked *M* in the illustration. The circuit is automatically completed alternately between the positive and the negative cables and the successive contact studs. *B+* and *B—* are the skates or runners, which are attached, as usual, to the under side of the car. It will be noticed that these runners are of such length that it is impossible for one of them to feed on more than two studs and that they are so placed that the leading, or positive runner entirely leaves the stud immediately in front of the trailing, or negative runner before the latter reaches that stud. The importance of this will be readily realized. The method by which the studs are made alternately positive and negative, is shown diagrammatically in Fig. 3. *E* and *E'* are two electromagnets, one fitted underneath the front part of the car and the other on the back part, both placed a short distance either side of the center line. *D* is the covering of the box and to it are connected electrically two short rods, T_1 and T_1'. There are two other rods, T_2 and T_2', which are placed near to and at the same level as T_1 and T_1', respectively. Of these T_2 is connected permanently to the positive feeding cable, and T_2' to the negative feeding cable. *L+* and *L—* are two movable soft-iron channels which are lifted by the magnets as the car passes over them. As shown in the illustration, *L—* lifts up and connects T_2' and T_1', thereby putting the stud cover, *D*, in direct communication with the negative feeder. A safety lever, *S*, of nonconducting materials is pivoted at *a* and so connected to the channel irons, *L+* and *L—* that it is impossible for both to be lifted at the same time. The magnets in the front of the car make connection to the negative feeder and those in the back connect with the positive feeder. When the front of the car is over any particular stud *L—* is lifted and the box cover, *D*, is therefore negative. As the car proceeds and the poles, *A B*, of the magnet leave the stud, the channel, *L—*, falls. Then the magnets, *E'*, operate in a similar manner on the same stud, lifting the channel, *L+*, and connecting the positive feeder with the stud cover. Fig. 4 shows the actual form of contact stud box. The box, *B*, is made of insulated material and closed by means of a thin cover, *D*, of non-magnetic metal. The rods, T_1 T_2 T_1' T_2', and the channels, *L+* and *L—*, are also shown, the latter moving in guides, *G*. *S* is the safety lever and *t* t_1 are the conductors for bringing the current from the positive and negative feeders to T_2 and T'_2, respectively. To each of these rods is connected a fuse shown at *C'*, in Fig. 5. The whole apparatus is fixed inside another box, the upper part, *A*, of which and the covering are of nickel steel. *C* is put on with a rubber joint so as to prevent the ingress of water. The connections between the cables and the contact box and between the box and the cover are made in the following manner: Each of the cables terminates in a metal box, *R*, which is filled with copper filings, and the fuses, *C'*, are provided with a pointed prolongation, *P*, which is plunged into the filings. Another box, *R*, also containing copper filings, into which is pressed the point, *P*, which is attached to the covering, joins this latter to the bars, T_1 and T_1'. The contact box, *B*, having no rigid connection with the fixed portion of the stud, is suspended elastically and isolated in this manner from any vibrations of the roadway. The elastic suspension is provided by means of two rubber supports, *O O'*. The lower part of the main box, *F*, is filled with insulating material, *I*, and forms the junction box between the cables and the pieces, *R*. The whole arrangement is insulated as far as possible from earth by casting a block of bitumen around it, so that all metal parts are covered up. As has already been explained, the current passes between the two rods, T_1, to the channel, L_1, thence to the rod, T_2. In order to prevent any possibility of these becoming permanently soldered together by the action of the current, the following ingenious device has been adopted: The channel, *L*, Fig. 6, is provided with a saddle, *c*, with two frames, *E E'* attached to it, so that the saddle cannot come off the channel. In the top figure the channel and saddle are shown lifted in making contact between T_1 and T_2. In the next position the channel, *L*, has fallen, but the saddle, *c*, is supposed to remain soldered to the rods, T_1 and T_2. The channel, *L*, however, is heavy and in falling is said to invariably break away any soldering which may have occurred by the force with which it strikes the frames, *E* and *E'*, and consequently the final position taken up by the various parts is shown at the bottom of the illustration. The system employed by M. Cruvellier for taking up the current is shown in Fig. 7, and consists of an endless metallic band, *T*, passing over two pulleys, *P*, placed under the car and running on the

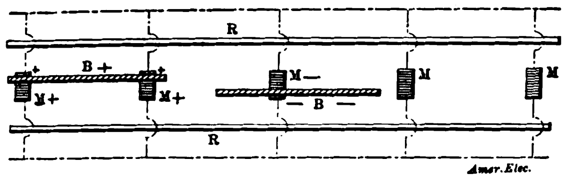

FIG. 2.—CRUVELLIER SURFACE CONTACT SYSTEM.

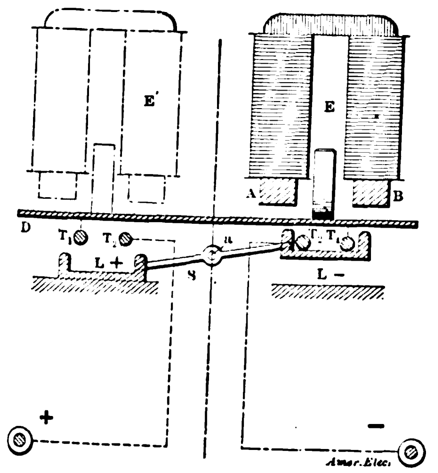

FIG. 3.—CONTACT STUDS.

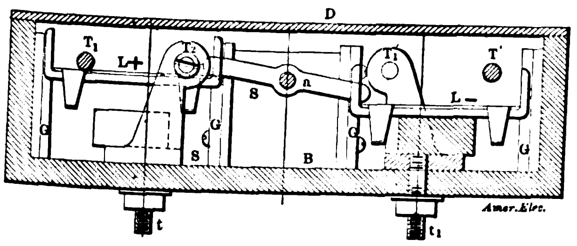

FIG. 4.—CONTACT STUD BOX.

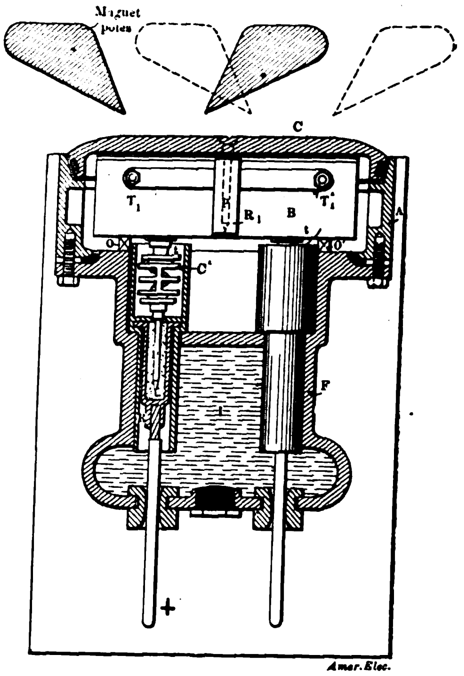

FIG. 5.—COMPLETE CONTACT BOX.

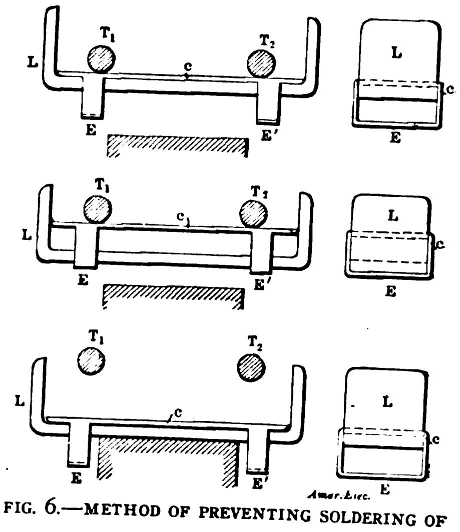

FIG. 6.—METHOD OF PREVENTING SOLDERING OF CONTACTS.

ground. The under surface of this band impinges on the contact studs, forming the necessary connection. The poles of the electromagnets shown in Fig. 5 do not touch the top of the studs, but are so placed as to pass about three-fifths of an inch away from it, and their strength is said to be such that this distance may be doubled without the stud ceasing to work.

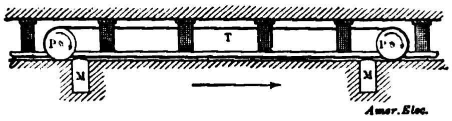

FIG. 7.—METHOD OF TAKING CURRENT.

Plotting Alternating-Current Curves.—Rudolf Goldschmidt describes in a recent issue of the *Elektrotechnische Zeitschrift* an instrument for plotting alternating-current curves based upon the principle that if the field of a magnet excited by alternating-current is traversed so rapidly by a coil that it completes the transit in a very small portion of the period of the alternating current, the e. m. f. induced in the coil is proportional to the instantaneous value of the magnet field, and hence to the magnetizing current. In the construction of the actual instrument both the primary magnetizing coil and the secondary coil, in which an e. m. f. is induced, are fixed; but both are brought together into an inductive relation for an instant by means of a movable iron piece which closes the magnetic circuit. The arrangement is shown in Fig. 8. Upon the horse-shoe magnet, *A*, the primary coil, S_1, is wound, which is excited by the alternating current, and its arms carry two secondary coils, S_2, connected in series. The magnetic circuit is usually open, but when the revolving copper drum, *B*, brings the iron plate *C* under the ends of the horseshoe the magnetic circuit is momentarily closed. The drum is revolved synchronously and the transformer may be moved in any desired position around its axis. The instantaneous value of the current at any desired phase is obtained by moving the transformer, *A*, to a corresponding position around the periphery of the drum. Placing both the primary and the secondary coils on the same iron has the disadvantage that the former induces an e. m. f. in the latter even when the magnetic circuit is open, but this disturbing e. m. f. is compensated by introducing an equal and opposite e. m. f. by means of an axiliary transformer connected as shown in Fig. 9.

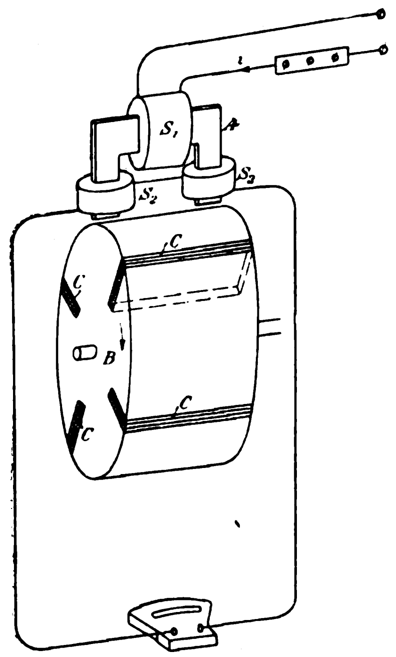

FIG. 8.—PLOTTING ALTERNATING CURRENT CURVES.

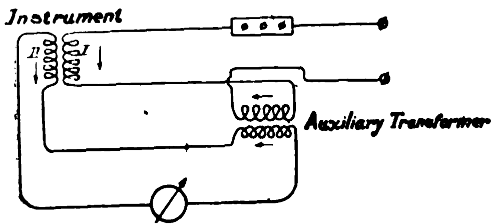

FIG. 9.—DIAGRAM OF CONNECTIONS.

Notes on Induction Motors.—H. S. Meyer contributes to a recent issue of the London *Electrician* some notes on induction motors. There are two essentially different forms of induction motors. First, the motor with a short-circuited rotor, or squirrel-cage type, which is ideal in its simplicity, but which requires a large current in starting at higher loads; second, the rheostatic motor, which consumes approximately the same amount of current when starting under full load as when running normally with the same load, but which requires a polar-wound rotor with variable resistance, either embodied in the rotor spider and revolving with it, or connected by means of slip rings and brushes to the rotor windings. As to the choice of the two kinds of motors, the author contends that there is no excuse for installing a motor of the rheostatic type where a simple squirrel-cage type can be used. While it is true that the latter motor requires a large current for starting, the exact amount depending upon the torque required and upon the design of the motor, still the type possesses the following advantages:

1. Simplicity in its construction; the rotor winding consisting of straight copper bars passing through the iron core and jointed together at the ends by short-circuiting rings.

	Squirrel-cage rotor.	Polar wound rotor.	Remarks.
Core loss	250 watts	250 watts	Remained approx. same, differing only by the errors in readings.
Stator I^2R	320 watts	320 watts	
Friction and windage	125 watts	270 watts	Tested.
Rotor I^2R	310 watts	285 watts 215 watts	Calculated from resistance of windings, the difference being due to contact resistance.
Efficiency, full	84.9	83.2	
Efficiency, half	84.1	80.6	
Power-factor, full	89	88	Found by dividing watts by volt amperes.
Power-factor, half	77	75.6	
Maximum output	15.5 h.p.	14 h.p.	
Starting torque	5.7 mkg.	4.5 mkg.	Torque coresponding to full load=3.9 mkg.
Starting current	114 amp.	26 amp.	Full current=19.9 amperes.
Rotor copper	6 kg.	12.5 kg.	

2. Avoidance of all sliding contacts and complications caused by the introduction of resistance at starting.

3. Greater simplicity in operation. The starting consists in a simple movement of a switch, while with the rheostatic motor skill in starting is required, if the full benefit from this type is to be obtained.

4. Adaptability to any number of poles, and thereby, the possibility of using an efficient method of varying the speed by changing the number of poles in the stator only.

5. Considerably better constants. The power factor is higher since the self-induction of the end connections is greatly reduced, and since the passage of the currents in the rotor bars is more favorable; also, the magnetizing current is generally less due to the lower densities in the rotor iron.

The efficiency is better since the copper is more efficiently used, as no dead copper in the shape of end connections is present, and since the wind resistance is smaller and all losses caused by brush friction and contact resistance are avoided. Wherever the slip-rings are short-circuited and the brushes lifted off the rings after the motor is up to speed, a smaller difference in efficiency will exist, but the complications introduced by such devices will hardly recommend their use, except in larger sizes.

To illustrate these points more fully the author gives some data of a 7.5-h.p., three-phase motor of 220 volts, which was first tested with a squirrel-cage rotor, and, secondly, with a wound rotor, slip-rings and outside resistance, using the same stator and the same bearings. Both rotors were of the standard type and of well-known make. The air-gap, according to most careful measurements, was exactly the same in both cases.

From the data given below which have been substantiated, it is claimed, by a number of similar tests, the author feels justified in saying that for motors which have to operate most of the time below their rated load, which is true of about half induction motors, an appreciable annual saving in cost of current can be effected by choosing the squirrel-cage type. Furthermore, its greater mechanical reliability and the absence of sparking, which reduces the chances for accidents and break-downs, and the less skilled attendance required, strongly recommend its use in mines and mills, where a delay in power, resulting from the failure of a motor, may have serious consequences. In dealing with motors which have to start light or with a small load, the author claims that the starting torque of the squirrel-cage rotor could be greatly reduced without impairing in any way the duties such motors have to perform. To obtain this in such a manner that the starting current taken from the line is reduced in the same proportion, a compensator may be introduced, which acts as a transformer, reducing the potential at the terminals of the motor, and, consequently, diminishing the current taken by it. Fig. 10 shows the connections between a compensator and a three-phase motor. The three-phase compensator consists of three coils wound upon laminated iron cores. When the switch is in the starting position the current from the line passes through the compensator, the windings of which are provided with a number of taps, so that various potentials may be obtained. Only one coil being used for primary and secondary, the two currents will flow in opposition, and consequently the windings need to be designed only for the difference in currents. As, further, the iron and copper densities may be chosen considerably higher than in ordinary transformers, in view of the short time of use, the size and cost of such a compensator is greatly reduced. Fig. 10 represents diagrammatically the conditions when using a compensator for the above 7.5-h. p. squirrel-cage type motor supposing it had to start with 30 per cent of its full load torque. The torque being proportional to the square of the impressed voltage, this may be reduced to

$$\sqrt{\frac{1.46}{0.30}} = 2.2 \text{ times, or to } \frac{220}{2.2} = 100 \text{ volts.}$$

The starting current at 220 volts being 114 amperes, the motor impedance is

$$\frac{220}{114} = 1.95 \text{ ohms.}$$

From this is found the motor-starting current at 100 volts approximately = 50 amperes. In reality, it will probably be somewhat less, since the impedance at full voltage due to saturation in the iron is mostly somewhat smaller than at reduced voltages, and thereby causes an increased current to flow under such conditions.

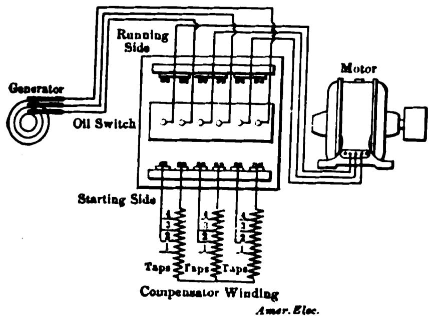

FIG. 10.—DIAGRAM OF CONNECTIONS.

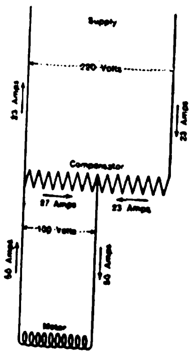

FIG. 11.

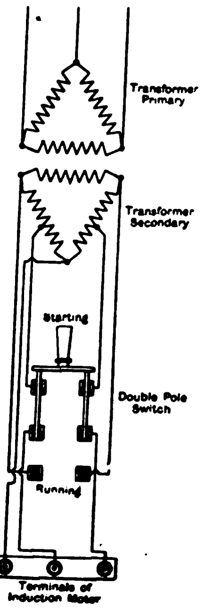

FIG. 12.

While in the secondary side there are 100 volts and 50 amperes, there are on the primary side 220 volts and 23 amperes. Thus, only a current 15 per cent larger than full load current is taken from the line. The winding of one part of the compensator has to carry 23 amperes, and the other 27 amperes, the currents flowing as indicated by the arrows in Fig. 11.

When the motor has attained its speed, the starting switch is thrown into the running position and the compensator windings are thereby entirely disconnected, the motor taking current directly from the line at full potential. Wherever induction motors are supplied by means of step-down transformers, as, for instance, in high-voltage transmissions, where it is not advisable to wind motors directly for voltages as high as 5000 or 6000, the starting taps may be conveniently provided right into the transformer secondary. By this means the cost of the squirrel-cage type of motor will be reduced so as to become about 10 per cent cheaper than a corresponding rheostatic motor. This method of starting has also been applied with success to rotary converters and synchronous motors, which, in the moment of starting, are comparable with squirrel-cage induction motors. A double-throw switch as shown in Fig. 12, will start an induction motor or converter on reduced voltage so as to prevent the flowing of excessive currents in the line. The illustration shows the advantage of the delta connection in such arrangements, which allows of starting by means of a tapping, say, at half the voltage, thus requiring only a double-pole instead of a triple-pole switch.

Some Recent Electrical Patents

Method of Treating Metallic Oxides in the Production of Metals and Alloys.—The employment of aluminum and the reducing action thereof for the treatment of metallic oxides in the production of metals and alloys has long been known, and various methods of employing aluminum for the purpose stated have been described, some of them a number of years ago. Until quite recently, however, no practical and successful results have been derived, owing to the fact that it has been impossible to control with reliability the reaction arising from hindrances and conditions which are themselves not under the requisite control. One of the first attempts in using aluminum as a reducing agent consisted in mixing it in a finely-powdered state with a metallic oxide in a crucible and then placing the crucible and its contents in a muffle and subjecting the whole to a heat which produced an explosive reaction for the charge in the crucible as soon as the aluminum was melted, with the result that the charge, the crucible, and the muffle were generally lost by being scattered and destroyed by the force of the explosion. Another attempt in using aluminum as a reducing agent for metallic oxides was by preparing a mixture of aluminum fillings and the oxides, which mixture was thrown or deposited upon a bath of molten aluminum contained in a crucible. This method resulted in an alloy of the aluminum with the metallic oxide employed in the given reaction, and the excess of aluminum was subsequently removed by placing more of the metallic oxide on the surface of the remelted alloy. Under this process there seems to have been no effort made to work by atomic proportions nor to specially prepare the oxides used in any given reaction, so that the resultant product was not perfect in every respect. Still another attempt to use aluminum as the reducing medium for metallic oxides was made by employing this reducing power of aluminum for the production of metallic manganese: under this process, manganese oxide was dissolved in cryolite, and in use the process was found to be an effective one. The latest and up to the present time the most effectual method of utilizing the reducing properties of aluminum in operating on metallic oxides, however, is said to consist in the employment of a process in which aluminum and metallic oxides in the form of a very fine powder have been mixed in atomic proportions, and after the mixture has been made, starting the reaction by igniting the charge at some one point, generally the surface, by the use of an easily-reducible oxide—such as, for instance, peroxide of barium—the usual practice being to start the ignition by inserting into the peroxide of barium mixture a strip of metallic magnesium ribbon and igniting the ribbon by means of a match; after the reaction has been once started additional mixture is supplied, making the method or process practically continuous. This process, while very effective so far as obtaining the benefits of the reducing property of aluminum on the metallic oxides, is open to the objection of introducing into the resultant product as impurities the easily-reducing oxide and the magnesia formed by the burning of the metallic magnesium strip or ribbon.

These various processes of utilizing the reducing action of aluminum on metallic oxides all have the disadvantage of an entire lack of any special preparation of the oxides, and this lack of preparation will at times cause an explosion of the charge and a consequent ejection of the mixture from the crucible; the cause of the explosions may be either instantaneous reaction or the presence of a trifle of moisture due to the hygroscopic character of some of the oxide used—as, for instance, boron trioxide; but ordinarily it is due to the fact that the material is moist when used or acted upon. There is between the extremes of utilizing finely-powdered aluminum in a crucible heated in a muffle, and the igniting of cold, very finely-powdered and, at times, moist charge, a definite mean, which when obtained, is said to result in a complete utilization of the reducing action of aluminum on metallic oxides and a process by means of which this mean result between the extremes just mentioned is said to be obtainable has been made the subject of a patent by Frederick C. Weber. Mr. Weber proposes to use a magnesia-lined crucible having located in the bottom a small flat coil of aluminum wire, as indicated in Fig. 2 herewith, above which spiral is placed the quantity of finely-powdered oxide which it is desired to reduce at one time. A small piece of tissue paper is placed above this finely-powdered oxide and on top of the paper is placed a helix of larger aluminum wire, as indicated in Fig. 1. Terminals are led out from the spiral at the bottom of the crucible, and also from the helix above it, as plainly shown in the latter engraving. A mixture of ordinary granulated aluminum is prepared, of which a quantity amounting to 95 per cent. of the complete mixture is combined and arranged in such relation to the upper coil of aluminum wire that the wire will be distributed evenly and uniformly throughout the mixture as a whole. After the mixture so prepared is placed in the crucible and compressed, an electric current of proper strength is applied to the terminals of the upper coil of aluminum wire until the entire charge will be brought to a temperature of about 212° Fahr., or to as much higher temperature as may be wanted. This first heat applied to the upper coil of aluminum wire drives off all moisture contained in the charge and prepares for the reaction treatment. The electric current is then turned off from the upper coil of aluminum wire and transferred to the lower coil; and the current for the lower coil should have strength sufficient to melt the wire. The melted aluminum of the lower coil at once reacts with the finely-powdered oxide or oxides with the result that the entire charge is under full reaction, producing in a few moments molten corundum, which makes its appearance on the surface, while a regulus of the metal of the oxide or alloy which is undergoing reaction forms at the bottom of the crucible. This mode of treatment, it is claimed, obviates all danger of explosion, and consequent injury and loss. It is also said to allow a cheaper granular aluminum to be employed in place of finely-powdered aluminum, and not to contaminate the reducing oxides that form material, as the electrical heat employed does not introduce into the product any impurities and the material need not be reduced to a fine powder before charging.

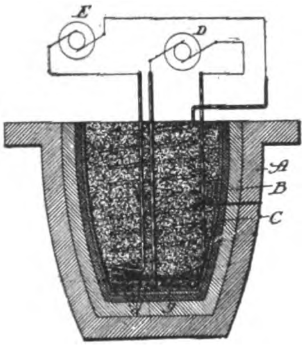

FIG. 1.

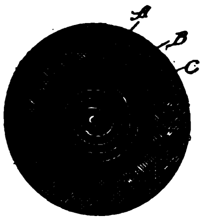

FIG. 2.

The inventor further states that this process permits the making of a compound molecule requiring more caloric than that furnished by the alumina reaction to be attained, as any deficiency of caloric will be supplied by electrically-heated wire. This extra supply of caloric from the hot wire enables the intensity of the heat of the reaction to be raised by just as much caloric as can be obtained by raising the temperature of the wire to a figure just below its melting point and thus bringing on a prematue reaction. The reaction can be further enhanced by the employment of a crucible lined with a spun thimble of sheet-aluminum, which makes practical the construction of any size of crucible-shaped vessel of plain magnesia brick. The thimble when the process above described is utilized will melt and react chemically with the mixture on the outside or exterior surface of the charge, with the result of lining the vessel or crucible with corundum, which, owing to its extreme infusibility, allows the vessel or crucible to be constructed of lime, and a vessel of this character renders practicable the production of a very solid regulus from any of the most refractory metals, such as chromium, uranium, tungsten, and others.

Referring again to the engravings, the crucible here illustrated consists of an outer containing vessel of metal, *A;* and an inner vessel, *B,* of lime or graphite, which is lined with mineral wool and magnesia, or mineral wool and finely-powdered lime, *C; D* and *E* are generators, of course, supplying current to the two coils of aluminum wire. Patent No. 705,727.

Automatic Line Catch for Broken Trolley Wires.—It is a matter of common experience and observation that when a railway trolley wire breaks, the fracture almost invariably occurs at or near the end of a supporting ear or hanger. Figs. 3 and 4 herewith illustrate a simple device which has been patented by George R. Floyd for the purpose of obviating the usual result of such an accident, that is, holding up the loose end of the broken wire. In Fig. 3 the trolley wire is illustrated as intact, and the emergency supporting wires, *d, d,* secured to auxiliary ears, *c,* are not in tension. In Fig. 4, where the trolley wire is represented as broken, the right-hand emergency supporting wire, *d,* prevents the broken end of the trolley wire from falling to the ground in a manner which is perfectly obvious. The restraining wires, *d* and *d* are attached to the auxiliary ears, *c* and *c,* by means of bolts adapted to slide in holes through the shanks of the said ears. This sliding connection is provided in order that the natural swaying of the trolley wire may not strain or break the emergency supporting wires, *d, d.* Patent No. 707,222.

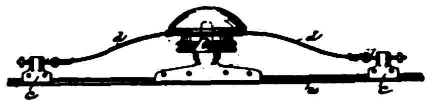

FIG. 3.—WIRE INTACT.

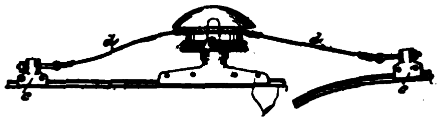

FIG. 4.—WIRE BROKEN.

NOTES.

American Street Railway Association.—The annual convention of this association is to be held in the Life Guard Armory, Detroit, Mich., October 8, 9 and 10. A number of interesting papers and an unusually large and varied list of exhibits are promised.

Association of Edison Illuminating Companies.—The twenty-third convention of this association will be held at the Mount Washington Hotel, White Mountains, N. H., beginning Tuesday, September 9. A goodly number of valuable papers are in course of preparation, and there are many other indications pointing to an extremely interesting and profitable meeting.

A New Light and Power Company for Atlanta.—According to the Atlanta press, a corporation known as the Atlanta Electric Company has applied for a franchise to install an electric light and power station in that city, the power plant to be operated hydraulically. It is reported that the company has obtained valuable water power property at Randall Shoals, and is prepared to establish a plant costing upwards of $1,000,000.

Barbed Wire Telephone Systems in California.—It is reported that the Pacific States Telephone & Telegraph Company has decided not to oppose the extension of barbed wire telephone systems, and has made special offers to supply farmers with instruments on a rental basis for use on barbed wire circuits. Telephone sets with batteries are offered at $6.00 a year, and long-distance connections over the company's lines will be given at regular rates. The barbed wire system is spreading rapidly throughout the farming districts of the state.

American Electrochemical Society.—The second general meeting of the American Electrochemical Society will be held at Niagara Falls September 15 to 18 inclusive. A large number of extremely interesting papers is scheduled for this meeting, as well as practical topical discussions. The headquarters of the association will be at the International Hotel, and the meetings will be held in the music room of this hotel. Arrangements have been made for the delegates to visit all of the local points of electrical and electrochemical interest.

A Joseph Henry Memorial.—The Albany Institute and Historical and Art Society, Albany, N. Y., recently passed formal resolutions expressing the desirability and appropriateness of establishing a Joseph Henry Memorial in Albany, where Henry was born, and has appointed a committee of five, to be known as the Joseph Henry Memorial Committee, for the purpose of conferring and co-operating with committees from other organizations in an endeavor to provide such a memorial. Full information on this subject may be obtained from Cuyler Reynolds, curator of the Albany Institute.

The Cable Lines of the World.—According to information published by the United States Treasury Bureau of Statistics, there are 1,750 submarine telegraph lines in the world, the aggregate length of which is nearly 200,000 miles. The number of messages annually transmitted over these lines exceeds 6,000,000.

A New York State Electrical Laboratory Projected.—At the recent session of the New York State Legislature a commission, composed of Edward A. Bond of Albany, Charles P. Steinmetz of Schenectady, and Harold W. Buck of Niagara Falls, was appointed for the purpose of determining the advisability of establishing a State electrical laboratory to provide independent authoritative information on questions of electrical science and official standardization of electrical measuring instruments, apparatus and standards. The commission is to report to the Legislature at the opening of its session in 1903, and if in its judgment the establishment of a laboratory is necessary, detailed plans and specifications for the construction and equipment of such a laboratory are to be prepared and submitted in connection with the commission's report.

In view of the enormous amount of capital invested in electrical industries in New York State and the almost innumerable sources of dispute between conflicting interests, such as telephone and street railway companies, the advisability of establishing such a bureau and laboratory would appear to be beyond debate.

Electric Power Projects in Europe.—The Societe d'Oerlikon proposes to establish at Pföffikon a hydro-electric power station having a capacity of 60,000 horse-power. It is intended to close up the Tinsiedelin valley so as to form there a lake about 12 kilometers square to serve as a reservoir for the water supply taken from the Reinchenbach and Grossbach rivers. Franchises have already been obtained without cost from the state, with the provision that the latter has the option of purchase for a period of 100 years. The cost of the undertaking is estimated at 40,000,000 francs (about $8,000,000), and the greater part of the required capital has already been secured.

The utilization of the waters of the Rhine in the vicinity of Mulhouse has been discussed for several years, but the magnitude of the undertaking being such as to limit the possibility of a cheap rate of production, the scheme has never been crystalized into practical shape. Recently, however, the feasibility of the project has been thoroughly investigated by Rene Koechim, who has installed several power stations of magnitude, and he and M. Potterat, of Berne, are reported to have filed with the Government plans for a proposed power generating and distributing plant. It is estimated that about 23,000 horse-power can be obtained. The required capital is about 15,000,000 marks (about $3,750,000).

Loss of Power in Fly-Wheels.—According to the London *Electrical Engineer,* a series of tests recently concluded in the Nurnberg central electricity station shows very clearly that the resistance which a fly-whhel offers to the air may give rise in some cases to a considerable waste expenditure of energy. The station in question is provided with two tandem compound engines of 450 horse-power each, direct-coupled to dynamos, and running at 95 r.p.m. In order to reduce the angular speed variations under the great variations of load which occur, a very heavy fiy-wheel was used, with arms of a channel section. These arms were found to offer a great resistance to the air and to create a powerful draught. It was therefore decided to cover the wheel with sheet iron in order to reduce the resistance and, therefore, the loss of power. In order to test the amount of energy lost, the dynamo was made to run as a motor and arranged to drive the engine and fly-wheel at no load. When the latter had no protecting covering the engine was found to absorb 13,300 watts, but when the covering was replaced it took only 9874 watts, thus showing a gain of 3426 watts, or 5.7 horse-power, this being 1.2 per cent. of the power of the engine. Counting the current price per kilowatt-hour and a day's run of seventeen hours, it was calculated that this represented an economy of nearly £56 annually. Another test of a similar nature was made upon a 630-h.p. engine, and this showed a saving in power as high as 30 horse-power, or 4.8 per cent. of the engine power, which was obtained by properly diminishing the air resistance of the fly-wheel.

Power Transmission Projects in California.—It is reported that contracts have been awarded to the General Electric, Westinghouse, and Bullock companies for the electrical machinery and apparatus to be used in the 110-mile transmission plant of the Kern River Power Company, California. The Bullock Company, it is stated, will supply five three-phase alternators of 2,000 kilowatts capacity each, while the General Electric and Westinghouse companies will supply the remainder of the electrical equipment. The power house will be located about 10 miles below Kernville, Cal., whence power will be transmitted to Los Angeles.

The McCloud River Electric Power Company, which recently awarded contracts for the construction of a dam 500 ft. long and nearly 100 ft. high, reports that the work on the new plant is proceeding rapidly. The hydraulic work is under the supervision of James D. Schuyler, a well-known engineer of Los Angeles. Stilwell-Bierce turbines and Bullock alternators will be used in the power house.

The Edison Electric Company of Los Angeles, Cal., which recently secured $3,000,000 on bonds for immediate use, and arranged for $7,000,000 additional funds to be supplied as needed for future developments, is pushing forward the work of expanding its facilities. The company now owns four water-power plants and two steam plants, and in addition to these owns two water-power sites on the Kern River and has options on two more. It is estimated that 80,000 horse-power can be transmitted to Los Angeles from the different sources of water power controlled by this company. A prominent official of the company recently expressed the opinion that there is not the least danger of an over-production of electricity in the territory tributary to Los Angeles.

Electrical Equipment for the New York Central Railroad.—It is announced that the New York Central & Hudson River Railroad Company has decided to abolish the use of steam locomotives on all tracks within thirty miles from the Grand Central Station in New York City, substituting therefor an electric traction system, which, when completed, will be one of the greatest in the world. Through trains will be hauled by electric motors to Croton Landing on the main line and to White Plains on the Harlem division, at which points the change to steam locomotives will be made. Suburban trains will be made up of coaches equipped individually with electric motors and operated as a multiple-unit system. The third-rail conductor will be used chiefly, the overhead system being used in only a few instances in the yards where the complication of tracks renders this system preferable to the third rail.

American Machinery for a British Tunnel Railway.—The last of the main generators and engines intended to be installed in the power plant of the Mersey River Tunnel Railway between Liverpool and Birkenhead, England, are about to be shipped from the Westinghouse works at East Pittsburg. These generators are of the direct-current railway type, of 1,200 kilowatts capacity at 650 volts, and are to be direct-connected to vertical cross-compound Westinghouse-Corliss engines of 1,500 horse-power each, running at 90 r.p.m. The power-house lighting and the electric lights of all stations, sidings, etc., will be supplied from a separate generating plant comprising two compound-wound dynamos, each having a capacity of 200 kilowatts at 650 volts, direct-connected to Westinghouse compound engines and running at a speed of 250 r.p.m. The Westinghouse electro-pneumatic system of train control is to be used and the cars will be equipped with Westinghouse high-speed air-brakes. The cars will be 60 ft. long. The trains will be formed of five cars each, the first and last cars of a train being motor-cars, equipped with four 100-h.p. motors each. The tunnel road is double tracked, about 4½ miles long, and the traffic on the line is heavy. The number of passengers carried with the steam locomotive system formerly operated was between 7,000,000 and 8,000,000 a year. The line is to be equipped with rail conductors, one conductor rail to be laid alongside and just outside of the running track, and a fourth rail to be laid between the track rails, so that the latter will not be "alive"; the object being to prevent any destruction of the track rails or buried pipes in the vicinity by electrolytic action.

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Depreciation of Central Station Apparatus.

In earlier days, when stations were small, rates for municipal service high, and competition unknown, the question of depreciation was not a particularly serious one, notwithstanding the fact that the actual rate of plant deterioration was much greater than that it is to-day because of the relatively inferior character of apparatus then used. But in the present day of rapid development, high standards and, in many cities, keen competition, depreciation has attained a rather formidable degree of importance. It makes a vast difference whether the actual reduction of plant value can be covered by a charge of five per cent., or whether ten or twelve per cent. is required.

A complicating factor in the problem is the rapid advancement in the art which renders apparatus practically obsolete within a few years, even while the apparatus is in excellent operative condition. Plant extensions also have this effect occasionally. It would seem, however, that this sort of loss should be considered as entirely distinct from depreciation, maintenance, construction or any other account, since it is of a wholly individual character. We should rather prefer to establish what might be termed either a "displacement" or an "improvement" account and fund to cover the supersession of machinery or apparatus still in good condition by new plant equipment of a more modern or more advantageous character; charging this account with the difference between the depreciation proper of the displaced machinery and the actual monetary loss sustained in sacrificing it. It is certainly illogical to charge off the loss in such cases to depreciation or any other of the accounts commonly carried on a central station ledger. The percentage to be charged to depreciation will naturally depend on the character of the apparatus, but central stations have been in operation for a sufficiently long period to furnish ample data on which to base equitable depreciation charges for each class of machinery and apparatus commonly operated.

The discussion of this subject at the last Electric Light convention was not productive of any definite policy as endorsed by a considerable number of central station men. In fact, the practices described and the opinions expressed were somewhat remarkable for their diversity. It is to be hoped, however, that President Ferguson has taken the matter up where his energetic predecessor left it, and will be able to bring about some degree of uniformity in the treatment of displacement or improvement, depreciation, etc., by central station managers.

The Squirrel-Cage Induction Motor.

There is an ancient and familiar maxim to the effect that everything "has its place," and the plain inference is that a thing is not of normal utility or efficiency when out of its proper "place." We know of nothing to which this maxim and its corollary can be applied with more force than to the squirrel-cage form of induction motor. It has most definitely and clearly its "place," and it is thoroughly and conspicuously unfit for use out of that place. In view of the universal recognition of these facts by unprejudiced and well-posted engineers, as well as a perfectly well-defined understanding of what the appropriate sphere of the squirrel-cage machine is, the rather laborious effort of a writer in one of the English papers to decry the polar-wound and eulogize the squirrel-cage motors appears gratuitous if not obtrusive.

The results obtained in a number of tests made on a three-phase stator with squirrel-cage and wound rotors, which are quoted on another page of this number, are interesting so far as they go, but they do not by any means support Mr. Meyer's contention to the effect that the squirrel-cage is generally preferable to the polar-wound rotor with a starting resistance. All of the specific advantages which he urges in favor of the squirrel-cage have been conceded long ago, except as to the constants of the two machines, and most of his claims in this direction are superfluous. Granting every point of advantage he ascribes to the squirrel-cage, however, does not modify the axiomatic fact that there are conditions of operation under which this simple rotor is an intolerable nuisance; and efforts to force it into service under these conditions merely make one appear absurdly partisan.

As we have repeatedly pointed out, the squirrel-cage rotor is a most beautiful conception, and where it can be used without objectionable effects on other parts of the system, it is absolutely unapproachable by any other arrangement. We do not believe there is a single well-informed engineer who is so prejudiced as to deny this statement or even desire to modify it. But all of the many advantages of this type of machine as operated under proper conditions, combined with all of the results of Mr. Meyer's or any other tests, do not for an instant justify attempts to use squirrel-cage machines on lighting circuits when frequent starts under load are required, or under any other of the well-known sets of conditions for which this type of rotor is not fitted. It would be of almost priceless benefit if this were not true—if the squirrel-cage were universally applicable, but inasmuch as this utopian condition is not even remotely prospective, we can see no advantage to be derived from efforts to disguise the well-known deficiencies of the apparatus when operated under one set of conditions by harping upon its features of excellence as manifested under a totally different set of conditions, and making elaborate tests to prove them all over again. Mr. Meyer's statement that there is no excuse for installing a rheostatic motor where a squirrel-cage type can be used is a rather feeble truism, about on a par with a recommendation not to buy a street railway motor and controller to perform the work of a stationary shunt-wound machine. And his suggestion of a compensator in the primary circuit is most timely, in view of the fact that both European and American manufacturers have been using this arrangement for some years.

Railway Speed Trials.

According to foreign contemporaries and the United States Consular Reports, the German Society of Mechanical Engineers has offered a series of prizes for the best-designed express train and locomotive capable of maintaining a speed of 75 miles per hour for three hours continuously, the train to provide accommodation for 100 passengers and their baggage. Just why this speed limit was chosen does not appear, unless it is because in the trials of high-powered electric cars last year on the Berlin-Zossen line it was found unsafe to go beyond 75 miles an hour—on that road. If there is this connection between the two speed trials, it confirms the impression generally entertained by engineers who are familiar with the matter to the effect that the chief purpose of the coming trial of steam locomotives is to demonstrate that they are superior to electric motors for high-speed heavy-duty railroad service. It is difficult to understand, however, how the projected trial is expected to demonstrate any such proposition, in view of the entire lack of parallelism between the conditions of the two sets of experiments.

At the trial of electric motors last year, the car equipment was built for a speed of 125 miles per hour, but the lightness of the roadbed and track prevented the realization of any such speed. Beyond 75 miles an hour, the track became so unstable as to cause the cars to oscillate and sway dangerously, so that the trial really was not decisive, the motor equipment being entirely too heavy for the speed to which it was restricted through no fault of its own. In the trial now to be held, the locomotives are to be especially designed for light-service track and only for the unsensational speed beyond which that class of track proved unsafe last year for motor equipment capable of 66 per cent. higher speed. It is entirely obvious that last year's trial proved nothing except the deficiency of the Berlin-Zossen track and roadbed, and that the coming trial can prove nothing of any consequence to modern railroad engineering, because of the ultra-conservative speed limit. It is further obvious that no comparison can be fairly drawn between the two trials; so that if any attempt to draw such a comparison should be made, it must be done at the expense of somebody's reputation for truth seeking.

The preparations now being made for the coming "speed contest" partake of a distinctly comic-opera flavor. On a track that any self-respecting railroad company would own and use, the accomplishment of the results specified by the German society would be a very easy task for either steam or electric locomotives. It is somewhat amusing, therefore, to note the extraordinary measures that are to be taken by the contestants in the design of locomotives for the prospective trials, such as boxing in the engine and train, doubling the usual boiler heating surface, spring-supporting the engine weight, using a large number of wheels, etc., in order to spare the delicate, sensitive track and obtain high fuel economy in the trip over its erratic undulations. It naturally occurs to one to suggest in a friendly spirit that the traditional pointed gas cylinder of the flying machine enthusiast be attached immediately above each car of the train so as to relieve the dear track of just as much weight as possible and at the same time lower the center of gravity of the car. Of course, a common ordinary American engineer would suggest that those interested should build a decent track and try for speeds worth while, with a rational equipment; but this would be very unacademic and commonplace.

It is an open secret that the State railroad officials of Germany are bitterly hostile to any encroachment upon what they are pleased to regard as their exclusive domain, and an unbiased observer might be pardoned for suspecting the existence of some sort of connection between their attitude and what appears to be an effort on the part of the Society of Mechanical Engineers to discredit electric traction. It is a notorious fact that the fossilism of the railroad bureaucrats defeated an attempt to establish high-grade railroad express service between Berlin and Hamburg some time ago, notwithstanding an abundance of capital behind the project. Incidentally, all these manoeuvers serve to illustrate the blessings and beauties of government ownership of public utilities. However, the Berlin-Zossen track is being rebuilt and well ballasted, through the persistent efforts of the Allgemeine Elektricitäts Gesellschaft and Siemens & Halske (heaven only knows what superhuman influences were brought to bear), and trials will be made this winter again with electric motors. Then a different tale may be told.

The Amateur Inventor Again.

If a report in a Cincinnati daily paper is authentic, there has been a brilliant addition to the ranks of the unfortunates who suffer from the delusion that a special dispensation of providence has fitted them, in lieu of schooling or other terrestrial preparation, for revolutionizing some science or industry based on science. A certain gentleman, who is referred to as "an inventor of note," has evolved the magnificent idea of "a form of permanent magnet in which there is no zero point or dead center." Exactly what is meant by this sciolistic phrase no one, we are convinced, can have the remotest idea, not even barring the inventor. According to the newspaper account, this misguided mortal has "discovered a method whereby its (the magnet's) pull on a piece of iron can be made to produce rotary motion. By this means it is possible to use the magnet's force in the driving of machinery or other application of power." In other words, this poor victim of his own ignorance has "invented" an electric motor in which the field of force is supplied by a permanent magnet and the armature is of iron without coils. No further quotation or comment is required to indicate the hopelessness of this "inventor's" case.

The pathetic side of such cases is the most conspicuous. It is really distressing to think of the toil and time wasted by this class of people in chasing *ignis fatuii*, when a few dollars invested in educational facilities and a few weeks of time devoted to the use of them would suffice to prevent any such entrance into a fool's paradise with the rude awakening that must inevitably follow.

CONSTRUCTION OF WIRELESS TELEGRAPH APPARATUS.

The Receiving Circuit.—Choking Coils and Shunts.

BY WM. A. DEL MAR.

The apparatus required in the receiving circuit includes the coherer, two choking coils, four non-inductive shunts, a telegraphic relay, a Morse inker or sounder, and a modification of the vibrating bell, called the "tapper." Besides these a number of batteries are required. Fig. 1 shows diagrammatically a complete receiving outfit. The amateur had better not attempt to make the relay, as not only is the manufactured article far better than any that could be constructed at home, but it is probably less costly. The coherer and tapper will be described in a later article.

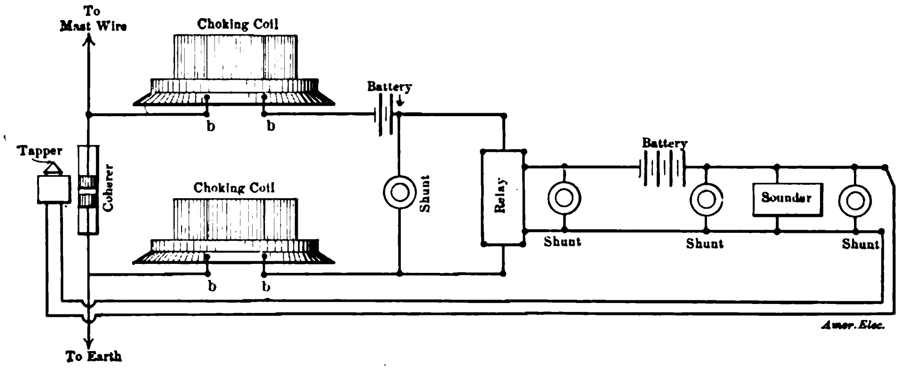

FIG. 1.—DIAGRAM OF COMPLETE RECEIVING OUTFIT.

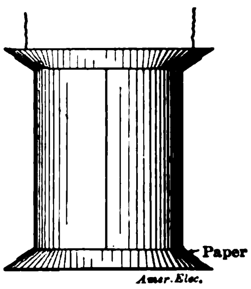

FIG. 2.

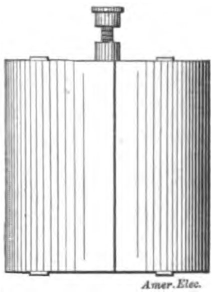

FIG. 4.

The shunts and choking coils are of far greater importance than would appear at first sight. The function of the non-inductive shunts is to obviate sparking at the contacts of the relay, tapper, and Morse receiver. They are made in the following way: About 30 yards of No. 31 B. & S. gauge silk-covered German silver wire are wound on each of two ordinary spools. The free ends from the two spools are soldered together, and the joint well insulated with silk. The wire is then ready for winding in double turns. A good-sized wooden spool, from which the thread and labels have been removed, is selected, and the double wire wound evenly on it, the two strands laying side by side. A sheet of paper, about the thickness of that used in this journal, is put between each layer of the winding and made to project a little beyond the latter at each end. The free ends of the wire are brought out at one end of the spool, as shown in Fig. 2. A few layers of coarse thread are then wound on the spool and varnished with shellac.

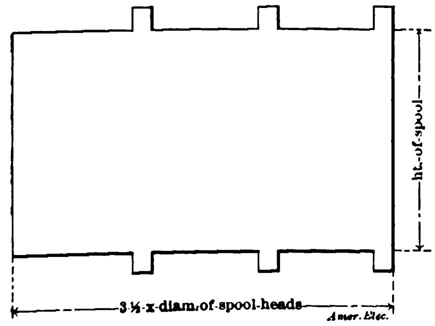

FIG. 3.—DEVELOPMENT OF ZINC CYLINDER.

The next operation is the making of a sheet-zinc cover to fit around the spool. A development of the zinc sheet before it is rolled into a cylinder is given in Fig. 3. The free ends of the cylinder being soldered together, the spool is fitted into it, and the projecting teeth bent over at right angles, so as to keep it in. One of the projecting wires is soldered to the zinc case, while the other is connected to a binding post at the center of the spool top. This post is screwed into a plug of wood which blocks up the central hole. The finished coil is shown in Fig. 4. Four of them are required, and each is put on a wooden base provided with a binding post connected to the zinc casing.

The next consideration is the choking coils. These are of rather unusual construction, as the consecutive layers are separated by a conductor, and the iron core is omitted. The wire employed is No. 25 B. & S. gauge cotton-covered copper wire. The bobbin is made in the following way: A disc of wood having a diameter of about 6 inches has six wooden pins driven into it at equidistant points on a circle of 5 inches diameter concentric with the edge of the disc, as shown in Fig. 5. They must project 4 inches above the wood. A sheet of tough paper is moistened and wound around these pins while wet. The ends of the paper are glued so that when it dries it forms a stiff drum-like surface, extending all the way around, as shown in Fig. 6. A sheet of tinfoil and then a sheet of thin paper are wound around this, but are not glued. The tinfoil sheets must be 6 ins. x 16 ins., so that two inches of it project beyond the wooden posts. The paper need be only four inches wide. Beginning at the bottom, the wire is wound on evenly until there is a complete layer 3¾ inches wide. Another sheet of thin paper, one of tinfoil, and still another of paper are put over this, and a second layer wound on evenly, as before. In this way 12 layers of wire are wound on, there being a sheet of tinfoil and two of paper between each layer, the sheet of tinfoil being always between the two sheets of paper. When the twelfth layer is on, it is covered by a sheet of paper; the tinfoil sheets are then slit at each post down to the winding, and the ends turned over towards the outside, as shown in Fig. 7. A sheet of zinc is bent into a substantially hexagonal form to fit very tightly over the coil and make good contact with the turned-down tinfoil sheets. The height of this zinc is 4¼ inches. With this cover on, the coil appears as shown in Fig. 8. Two such coils are required. In each of them the ends of the copper wire are simply brought through the base to binding posts, as shown at *b b* in Figs. 1 and 8. The zinc case may be finished with black paint to prevent oxidation.

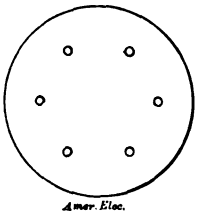

FIG. 5.

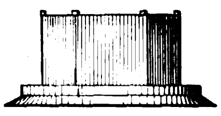

FIG. 6.

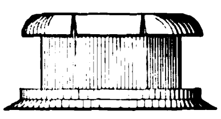

FIG. 7.

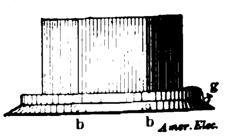

FIG. 8.

The circuit diagram, Fig. 1, shows the disposition of the shunts and choking coils. One or two dry cells will do to operate the relay circuit—a larger number would probably injure the coherer. In the local sounder circuit a larger number of cells may be employed with advantage—the number depending on the resistance of the instrument.

The rationale of the working is as follows: The excessively rapid alternating potential in the aerial conductor acts on the coherer in such a way that its resistance is decreased. The choking coils, however, prevent this alternating potential from sending a wasteful current through the relay circuit. The relay battery is thus able to send a current through the coherer and relay, thereby operating the latter. The shunt serves to dissipate the "extra current" due to the self-induction of the relay magnet. The relay being in operation, the main battery is enabled to send a current through both the Morse receiver and the "tapper." The former gives the signal, and the latter, by tapping the coherer, renders it non-conducting. The function of all the shunts is to afford a path for the currents due to the self-induction of the instruments, and thus do away with local sparks which might affect the coherer. The object of the tinfoil sheets between the consecutive layers of wire on the choking coils is a follows: With the excessively rapid surgings of potential which the aerial conductor undergoes, a condenser of very moderate capacity offers a better path for the current than does even a good conductor. Hence, it is necessary to prevent consecutive layers of wire from acting as the plates of a condenser. This is effected by the use of intermediate sheets of tinfoil. This electrostatic effect is so powerful that if the ground wire or aerial conductor be broken and the wires separated even as much as an inch, the action will not be impaired, because the ends of the wires will act across this space like two sheets of a condenser. For this reason the choking coils should not be placed too near any grounded wires or pipes.

During the receipt of a signal, the tongue of the relay makes a number of rapid oscillations, which, however, should produce no effect on the Morse receiver, because of the great inertia of the moving parts of the latter instrument.

◆

PROTECTION, MAINTENANCE AND DEPRECIATION OF STORAGE BATTERIES.

Methods of protecting storage batteries operated, in connection with rotary converters, when the alternating current side is interrupted, and the matter of storage battery maintenance and depreciation, were subjects of extended and interesting discussion at the Cincinnati Electric Light Convention. The "Question Box" contained the inquiries:

"How may storage batteries be protected, operating in connection with induction or synchronous apparatus, when interruptions occur on the transmission line?" and "What is the cost of maintenance and depreciation of storage batteries?"

Responding to the first query, Mr. Lamar Lyndon, of New York, stated that storage batteries may be protected when operated as described, and prevented from discharging back through the converting apparatus when interruptions occur on the transmission line in several ways, depending on whether the machines are used for charging only, or whether they are to be used reversibly; that is, on useful discharge the energy from the battery converted back into alternating currents and fed into an alternating-current system. In the first instance the ordinary underload circuit-breaker, interposed between the charging machine and the battery, will protect the latter. A polarized relay circuit-breaker or an underload circuit-breaker of an ordinary type will also meet the requirements. The polarized relay may be constructed with a permanent magnet, or the poles may be produced by an exciting coil connected to the battery terminals, as the electromotive force at these terminals is always in the same direction, whatever may be the direction of current flow.

The above-mentioned circuit-breakers cannot be used where the battery is to discharge back into the alternating-current line, passing through an inverted rotary converter or synchronous motor-generator, since reversal of current direction in the direct-current side would cause the circuit to open. The method most suitable for this case—which is a somewhat rare one in practice—is to make a spring-controlled circuit-breaker to open the battery circuit, the latch being held in by the tongue of a small motor which receives current from the alternating-transmission line, and which is similar to a well-known alternating voltage regulator. Those familiar with this device understand that the armature does not rotate continuously, but simply exerts a torque. The regulator mentioned is a reactive device, the torque being merely incidental and not in anywise useful; but a very small apparatus, made on the same lines and excited from a transformer such as is used in connection with station voltmeters could be made to operate the circuit breaker latch; nor would the complete combination be expensive, nor as complicated as might be inferred.

It may be added that the batteries in any case would not greatly need protection, as they would drive the converter or motor generator, as a motor, and the counter electromotive force would prevent abnormal current flow; in fact, the current discharged by the battery would be only that necessary to drive the machine operating at no load, and the consequent energy loss would simply be that due to the friction and internal losses of the translating machine.

Mr. R. H. Pierce, of Chicago, said that if the object is to protect the battery, then it can best be protected by fuses or by some kind of circuit-breaker having a time limit. It will not do to have the storage battery thrown out of service by an instantaneous overload, even if this overload amounts to many times the capacity of the battery. On the other hand, one cannot afford to overload the battery for any length of time with such a heavy short-circuit that it would warp the plates. In the latest installation of this kind made by Mr. Pierce, the battery was protected with copper fuses rated at about twice the one-hour discharge rate of the battery. This saved the battery which had about 200-kilowatt capacity, and which otherwise would have had to carry about 1000 kilowatts. The person asking the question may have had in mind more particularly the protection of the apparatus than the protection of the battery. A serious trouble that has occurred where a storage battery has been used with rotary converter has been that the rotary converter when running with a light field has acted as an inverted rotary and run away. When there is almost unlimited power in a battery, this may mean the destruction of the rotary unless it can be cut out of circuit. There are two ways of avoiding this: The first way is to have the rotary excited by an exciter belted to the rotary or direct-coupled to it, so that as the speed increases, the field of the rotary will strengthen and prevent running away. The other method is to have some kind of centrifugal speed-limiting device attached to the shaft of the rotary so that at a certain speed an electrical contact is made which automatically opens the switch controlling the rotary and puts it out of circuit.

In reply to the second question—as to the cost of maintenance and depreciation of storage batteries—Mr. Pierce said that in general, and assuming average conditions, if there be such, the positive plates should last three or four years. Should they last four years, the annual cost of maintaining the plates would amount to ten per cent. of the original cost of the plates. To this would have to be added the cost of making the changes of plates, which would depend upon circumstances. If the plates lasted three years, this would make the depreciation equivalent to fifteen per cent. These figures ought to cover all depreciation. Of course, the cost will be different where a battery is used for railway work and where it is used to its capacity for doing heavy lighting work, from the cost where it is used simply to float on the line in connection with lighting work. The above statement is based on what the central station manager would have to be prepared to face under average conditions.

As regards the maintenance, this depends upon the location of the battery—whether or not it can be inspected by a man that is also doing other work; and maintenance in the sense of putting the battery in good condition is covered by the item of depreciation. The figures given would probably not be accepted by the battery men. One battery in New York is guaranteed at six per cent. maintenance for three years, but Mr. Pierce did not consider that a three years' maintenance guarantee amounts to anything. The best way to find out what the maintenance of a storage battery costs, is to see what the makers will guarantee on a ten-year contract under the actual working conditions. Mr. Pierce said he installed a battery under these conditions where the maker agreed to maintain the battery for about five per cent. of the cost of the plates and tanks, but this is probably too low for anything like the average condition.

Mr. Lyndon considered the cost of maintenance and depreciation of storage batteries a question that cannot possibly be answered without complete data as to the size of the battery, the work that it is doing, the quantity and density of the electrolyte, the character of the plates, and the minimum voltage at which they are allowed to discharge. If the battery is used for regulation, alternately charging and discharging at intervals not widely apart, the plates should have a comparatively thin layer of active material and, for a given quantity of active material should have a considerable area exposed to the action of the electrolyte. If the batteries are to be used for storage purposes, being charged full during hours of light load and discharged on the peaks, these same conditions should hold, provided the rate of discharge is rapid. On the other hand, if the discharge is comparatively slow, a thick layer of active material will be more suitable.

Generally speaking, if a battery conforms to the following specfications and limits of operation, the maintenance and depreciation should come within 9 or 10 per cent:

1. Rate of charge or discharge never to exceed twelve amperes per square foot of active surface; the active surface to be considered as the length multiplied by twice the breadth, of each of the positive plates. Twice the breadth is taken in order to cover both sides of the plates. Of course, this is only an average value, applicable to most of the usual types. There are, however, batteries for which the rate given may be exceeded with safety.

2. The temperature at which they are operated never to exceed 100° Fahr.

3. The density of the electrolyte not to exceed 1.24 when the battery is fully charged.

4. The quantity of electrolyte to be not less than ten pounds per 100 ampere-hours of battery capacity.

5. The electrolyte to be pure and to contain no metals or lead dissolving acids.

6. The density and quantity of the electrolyte always to be maintained at the original values.

7. The battery never to be permitted to discharge below 1.85 volts per cell, the reading being taken when the normal current rate is passing, of 1.8 when the discharge is at the maximum permissible rate.

TABLE III.—GIVING THEORETICAL WORKING PRESSURES FOR BOILERS OF DIFFERENT DIAMETER, THICKNESS OF SHELL, FACTOR OF SAFETY AND TYPE OF JOINT.

Assumed strength of plates 55,000 lbs.

The assumed eff. of joints, single lap 54%, double lap 70%, double butt, 80%, triple butt 88%.

Diameter of Boiler	Thickness of Shell.	Factor of safety 6				Factor of safety 5				Factor of safety 4			
		Kind of joint.				Kind of joint.				Kind of joint.			
		Single Lap	Double Lap	Double Butt	Triple Butt	Single Lap	Double Lap	Double Butt	Triple Butt	Single Lap	Double Lap	Double Butt	Triple Butt
30"	¼	82	107	123	137	98	128	147	163	123	160	184	204
	5/16	103	134	155	172	124	161	186	205	155	201	232	257
	⅜	124	161	186	205	148	192	221	245	185	240	277	307
	7/16	145	188	217	240	173	225	259	286	216	281	324	358
	½	165	215	248	275	198	257	296	328	247	321	370	410
36"	¼	69	90	103	115	82	107	123	137	103	134	154	171
	5/16	86	112	129	143	103	134	154	171	129	168	193	214
	⅜	103	134	155	171	123	160	185	204	154	200	231	255
	7/16	120	157	181	201	144	187	216	239	180	234	270	299
	½	138	180	207	229	165	214	247	274	206	268	309	342
42"	¼	59	76	88	98	70	91	105	117	88	114	132	146
	5/16	73	96	110	122	88	115	132	145	110	143	165	182
	⅜	88	115	133	147	105	137	158	175	132	171	198	219
	7/16	103	134	155	170	123	160	185	204	154	200	231	255
	½	118	154	178	197	142	184	212	235	177	230	265	294
48"	¼	52	67	77	86	62	80	92	102	77	100	115	128
	5/16	64	84	96	106	77	100	115	127	96	125	144	159
	⅜	78	100	116	129	93	120	139	154	116	150	174	193
	7/16	90	118	135	150	108	140	162	179	135	176	203	224
	½	104	135	155	172	124	162	185	205	155	202	232	257
54"	¼	46	59	68	76	54	70	82	90	68	88	102	113
	5/16	58	75	86	96	69	90	103	114	86	112	129	143
	⅜	69	90	103	115	82	107	123	137	103	134	154	171
	7/16	80	105	120	134	96	125	144	159	120	156	180	199
	½	92	119	137	152	109	142	163	182	137	178	205	227
60"	¼	41	53	62	68	49	64	73	82	62	80	92	102
	5/16	51	67	77	86	62	81	93	102	77	100	116	128
	⅜	62	81	93	102	74	96	110	122	93	120	138	153
	7/16	72	94	109	120	87	112	129	143	108	140	162	179
	½	82	108	124	137	99	128	148	164	124	160	185	205
66"	¼	38	49	56	62	45	58	67	74	56	73	84	93
	5/16	47	61	70	78	56	73	84	93	70	91	105	116
	⅜	56	73	84	92	67	87	100	113	84	109	126	139
	7/16	66	85	98	109	78	102	118	130	98	127	147	163
	½	75	98	113	125	90	117	134	149	112	146	168	186
72"	¼	35	45	51	57	41	54	61	68	52	67	77	85
	5/16	43	56	65	71	51	67	77	85	65	84	96	107
	⅜	51	67	77	85	61	80	92	102	77	100	116	127
	7/16	60	78	91	101	72	94	108	119	90	117	135	145
	½	69	90	104	114	82	107	123	137	103	134	155	171

It will be seen that there are several conditions, but they are no more onerous than those required in the successful operation of any dynamo electric machine. It may be noted that the difficulties that have attended battery operation in this country have arisen largely from an attempt to perform work with too small a battery. Increased battery capacity not only reduces the depreciation and cost of maintenance, but increases the efficiency to a marked extent. The question, also, of proper quantity of electrolyte does not seem to have received the attention in this country that so important a factor deserves.

In addition to the requirements mentioned, others with reference to prevention of excessive overcharge, not allowing the cells to stand uncharged in the electrolyte, cleaning out the sediment in the bottom of cells, etc., are to be understood.

NOTES ON TUBULAR BOILERS.

BY CHAS. L. HUBBARD.

Boiler Horse-Power.—The standard established by the Committee of Judges at the Centennial Exhibition, in 1876, as a "boiler horse-power" is the evaporation of 30 lbs. of water from a temperature of 100 degrees into steam at 70 lbs. gauge pressure. This is equivalent to the evaporation of 34½ lbs. from a temperature of 212 degrees into steam at atmospheric pressure, and requires 34½ × 966 = 33.327 heat units, which, for practical purposes, may be taken as 33,000.

Heating Surface per Horse-Power.—It has been found by experience that in plain tubular boilers one square foot of heating surface will evaporate 2.3 lbs. of water "from and at" 212 degrees, which corresponds to 15 sq. ft. of heating surface per horse-power (34.5 ÷ 2.3 = 15). In well-proportioned boilers, with careful firing this can be somewhat reduced, and some authorities give as low a figure as 11½. All computations and tables given later in this article are based on 15 sq. ft. per horse-power, which experience has found to be safe and to result in durable construction. In computing the heating surface of tubular boilers it is customary to take one-half the area of the shell, two-thirds the rear head minus the tube area, plus the interior surface of all the tubes.

TABLE I.—NON-CONDENSING PLANT.

Boiler Press Gauge	Ratio of Expansion					
	2	3	4	5	7	10
	Pounds of steam per horse-power per hour					
30	40	39	40	40	42	45
45	35	34	36	36	38	40
60	30	28	27	26	30	32
75	28	27	26	25	27	29
90	26	25	24	23	25	27
105	25	24	23	22	22	21
135	24	23	22	21	20	20

Heating Boilers.—The horse-power required for warming a building may be computed in different ways according to the data at hand. It may be based on the radiating surface to be placed in the building, or upon the heat lost through walls and windows, and the heat lost by ventilation if that is to be supplied. The maximum number of heat units given off per square foot per hour for different kinds of radiating surface under usual conditions in zero weather, using low-pressure steam (5 to 10 lbs.) may be taken as follows:

Direct radiation, cast iron	250
Direct radiation, pipe coils	330
Indirect radiation	700
Steam blast	1,800

Therefore, 33,000 ÷ 250 = 132 sq. ft. as the amount of direct radiating cast-iron surface which one boiler horse-power will supply. Similarly, one horse-power will supply 100 sq. ft. of direct pipe-coil surface, 47 sq. ft. of indirect radiation, and 18 sq. ft. of steam blast. As already stated, these figures are maximum, and should give a safe margin. Where the horse-power is to be computed on the heat unit basis, the heat loss from the building must first be calculated by one of the various rules used for this purpose. The total number of heat units required, divided by 33,000, will give the boiler horse-power necessary for warming. A good rule for approximating the heat loss from a building of ordinary wooden or brick construction, plastered inside, in a moderately exposed location, for zero weather, is as follows:

TABLE II.—CONDENSING PLANT.

Boiler Press Gauge	Ratio of Expansion					
	2	3	4	5	7	10
	Pounds of steam per horse-power per hour					
15	25	23	22	21	20	19
30	25	23	23	22	21	20
45	26	24	24	22	21	20
60	26	25	25	23	22	24
75	27	26	25	24	25	27
105	28	27	27	26	28	32
135	30	28	28	30	35	40

Wall surface × 15.
Glass surface × 70.
Cubic contents × 1.3.

The sum of these products × 1.16 gives

the heat loss from the building per hour, and this quantity divided by 33,000 will give the horse-power of boiler required for warming. Where the attic space is small, or the roof construction such as to admit the inward leakage of cold air, it is well to increase the above result 10 per cent.

The following figures taken from "Steam" are sometimes used for rough approximations, and give the cubic feet of space which one boiler horse-power will heat by direct radiation:

	Cubic feet.
Brick blocks in cities	15,000 to 20,000
Brick stores in cities	10,000 to 15,000
Brick dwellings exposed on all sides	10,000 to 15,000
Brick mills, shops and factories	7,000 to 10,000
Wooden dwellings, exposed on all sides	7,000 to 10,000

If ventilation is to be provided, the number of cubic feet of air to be supplied per hour multiplied by the number of degrees in temperature the air is to be raised in the coldest weather, divided by 55, will give the heat units required for ventilation, and this in turn divided by 33,000 will give the boiler horse-power to be added to that required for warming.

TABLE IV.—DIMENSIONS FOR TUBULAR BOILERS.

Dia. of boiler	No. of tubes	Dia. of tubes	Area through tubes in sq. ft.	Sq. ft. H.S. in heads	Sq. ft. H.S. in 1 lin. ft. shell and tubes	H.P. in 1 lin. ft. shell and tubes.	Length of tubes	Horse-power	Rate of evaporation 9 lbs. steam per lb. of coal: Size of grate	Size of uptake	Area smoke-pipe, sq. in.	Coal per sq. ft. grate per hr.	Rate of evaporation 8 lbs. steam per lb. of coal: Size of grate	Size of uptake	Area smoke-pipe, sq. in.	Coal per sq. ft. grate per hr.
30	28	2½	.78	2.8	20.7	1.37	6	8.5					24x36	10x14	140	6
							7	9.9					24x36	10x14	140	7
							8	11.2					24x36	10x14	140	8
							9	12.6					24x42	10x14	140	8
							10	14.0					24x42	10x14	140	8½
36	34	2½	.97	4.0	25.0	1.67	8	13.6					30x36	10x16	160	8½
							9	15.3					30x42	10x18	180	8½
							10	16.9					30x42	10x18	180	9
							11	18.6					30x48	10x20	200	9
							12	20.9					30x48	10x20	200	9½
42	34	3	1.44	5.3	30.2	2.0	9	18.5	36x36	10x20	180	9	36x42	10x20	200	8½
							10	20.5	36x36	10x20	180	9½	36x42	10x20	200	9
							11	22.5	36x36	10x20	180	10½	36x48	10x25	250	9
							12	24.5	36x36	10x20	180	11½	36x48	10x25	250	9½
							13	26.5	36x42	10x22	200	11	36x48	10x25	250	10½
							14	28.5	36x42	10x22	200	12	36x54	10x28	280	10½
48	44	3	1.86	7.2	38.4	2.56	10	30.4	42x36	10x22	200	11	42x48	10x28	280	9
							11	33.2	42x36	10x22	200	12	42x48	10x28	280	10
							12	35.7	42x42	10x25	220	11½	42x54	10x32	320	10
							13	38.3	42x42	10x25	220	12	42x54	10x32	320	10½
							14	40.8	42x42	10x25	220	12½	42x60	10x36	360	10½
							15	43.4	42x48	10x28	250	12	42x60	10x36	360	11
							16	45.9	42x48	10x28	250	12½	42x60	10x36	360	11
54	54	3	2.28	9.3	46.4	3.10	11	34.6	48x42	10x28	250	9½	48x54	10x38	380	8½
							12	37.7	48x42	10x28	250	10	48x54	10x38	380	9
							13	40.8	48x42	10x28	250	11	48x54	10x38	380	10
							14	43.9	48x42	10x28	250	12	48x54	10x38	380	10½
							15	47.0	48x48	10x33	290	11½	48x60	10x40	400	10
							16	50.1	48x54	10x38	320	12	48x60	10x40	400	11
	46	3½	2.67	8.8	46.3	3.10	17	53.0	48x54	10x38	320	12½	48x60	10x40	400	11½
60	72	3	3.04	11.2	59.6	4.0	12	48.4	54x48	10x38	320	10	54x60	12x40	460	9½
							13	52.4	54x48	10x38	320	10½	54x60	12x40	460	10
							14	56.4	54x48	10x38	320	12	54x60	12x40	460	11
							15	60.4	54x54	12x35	370	12	54x66	12x42	500	10½
							16	64.4	54x54	12x35	370	12½	54x66	12x42	500	11½
	64	3½	3.71	10.5	62.4	4.16	17	71.4	54x60	12x40	400	12½	54x72	12x48	550	11½
							18	75.6	54x60	12x40	400	13½	54x72	12x48	550	12
66	90	3	3.80	13.5	74.2	4.95	14	70.1	60x54	12x40	400	12	60x66	12x48	500	11
							15	75.0	60x60	12x44	450	12	60x72	12x52	620	11
							16	80.0	60x60	12x44	450	12½	60x72	12x52	620	12
	78	3½	4.52	12.6	75.2	5.10	17	86.0	60x60	12x44	450	13	66x72	12x56	670	11½
							18	91.1	60x60	12x44	450	13½	66x72	12x56	670	12
							19	96.2	60x66	12x48	500	13	66x72	12x56	670	12½
	62	4	4.32	12.4	69.2	4.60	20	93.1	60x66	12x48	500	13	66x72	12x56	670	12
72	114	3	4.81	15.7	92.5	6.16	14	87.4	66x60	12x48	500	12	66x72	12x56	670	11½
							15	93.6	66x60	12x48	500	13	66x72	12x56	670	12
							16	99.7	66x60	12x48	500	14	72x72	12x62	740	12
	98	3½	5.75	15.0	93.0	6.20	17	106.4	66x66	12x52	540	13½	72x72	12x62	740	13
							18	112.6	66x66	12x52	540	14	72x78	12x66	790	12½
							19	118.8	66x66	12x52	540	14½	72x78	12x66	790	13
	72	4	5.02	15.0	79.7	5.31	20	107.3	66x60	12x48	500	14½	72x72	12x62	740	13

Small heating boilers have been found to be less efficient than those of larger size, depending partly upon their construction, but more especially upon the unskilled firemen usually employed in caring for them. The following corrections computed from data given by Professor Carpenter may be used for increasing the power of the smaller sizes when calculated by the rules already given:

Boilers of 5 horse-power; multiply by 1.4
" " 10 " " " 1.23
" " 15 " " " 1.14
" " 20 " " " 1.07

The actual power of boilers depends largely upon the chimney draft, care of heating surface and management of fires, so that in many cases they may be made to develop under favorable circumstances a capacity at least 30 per cent. above that at which they are rated. It is not well, however, to force boilers in this way for any length of time, as it is both wasteful of fuel and injurious to the boiler itself.

Power Boilers.—Computations for power boilers are based upon the steam consumption of the type of engine to be used. The following table from Professor Thurston's "Manual of the Steam Engine" gives the average quantity of steam required per horse-power per hour by different types of engines working under different ratios of expansion. This applies to the best class of engines in common use when of moderate size and in good working order. Small engines having greater proportional losses in friction, leaks, radiation, etc., and besides receiving less care in construction and running than larger ones, require more steam per horse-power. In such cases the figures in the following table should be increased at least 50 per cent.

Having ascertained from the table the weight of steam required per hour by the engine under consideration, and knowing the probable temperature of the feed-water and the boiler pressure to be carried, the weight of steam can be reduced to an equivalent evaporation "from and at 212 degrees," and this result divided by 34½ will give the minimum boiler horse-power required. If steam is required for any other purpose, such as the running of pumps, blower or stoker engines, or for heating, it must be provided for in addition, of course.

Rate of Combustion.—The amount of coal burned per square foot of grate varies with the chimney draft, kind of coal used, and the care taken in firing. With power boilers having chimneys of good height, the amount is rarely less than 15 lbs., while from 8 to 10 lbs. is a fair average for heating boilers. This, however, is often much less in poorly cared-for boilers of small size.

Rate of Evaporation.—This, in well-proportioned boilers with clean tubes, may vary from 8 to 10½ lbs. of steam per pound of coal. Professor Carpenter gives 9 lbs. as an average for power boilers, and for small sized heating boilers, the following:

Horse-power of Boiler.	Rate of Evaporation. Pounds.
5	5.7
10	6.5
15	7
20	7.5
30	8

Grate Surface.—The square feet of grate surface required per horse-power can be computed by the formula

$$\frac{34.5}{A \times B}$$

in which *A* is the rate of evaporation, and *B* is the rate of combustion. This is true, because the weight of steam per pound of coal multiplied by the pounds of coal burned per square foot of grate will give the weight of steam evaporated per square foot of grate per hour; therefore, 34.5 divided by this quantity will give the square feet of grate required per horse-power. Inserting in the formula the rates of evaporation and combustion already given, we have

$$\frac{34.5}{9 \times 15} = .26$$ sq. ft. per horse-power for power boilers; and

$$\frac{34.5}{8 \times 10} = .43$$ sq. ft. per horse-power for heating boilers. These may be taken as limiting values for usual conditions, and may be varied to suit the case in hand as affected by height of chimney, etc.

Uptake and Smoke Pipe Areas.—Having

ascertained the size of grate required, the area of the uptake and smoke pipe can be determined by means of ratios which have been found in practice to give satisfactory results. This ratio for the uptake is 1 to 7, as compared with the grate area; the ratio of smoke pipe area to grate area ranges from 1 to 7 down to 1 to 10 for heating boilers, and from 1 to 8 down to 1 to 10 for power boilers.

General Proportions.—The diameter and other general proportions of a boiler are determined, of course, by the output required, the pressure to be carried, and in some cases by the available space in the boiler room. In most cases, especially where a considerable amount of power is required, it is better to use two or more boilers of smaller diameter rather than a single one of very large diameter. The allowable pressure to be carried on any given boiler depends, of course, upon the thickness of the shell plates, the diameter of the boiler, type of seams and quality of material. Table III herewith gives the safe working pressures for boilers of different diameters, different thicknesses of plate, etc. In applying this table, however, it is well to select a boiler having a shell 1-16 in. thicker than that specified by the table for a given set of conditions, in order to offset the effects of corrosion.

Short boilers are usually made in two sections, while those of greater length are made up of three. Care should be taken to see that the longitudinal seams of adjoining sections are not in line with each other, and, moreover, that they are well above the fire line of the boiler setting.

Tubes and Tube Sheet.—The size and arrangement of the tubes are matters of much importance. In general, the length of a tube should not exceed sixty times its diameter. A common rule is to allow one inch of diameter for each four feet of length where soft coal is to be used, and one inch in diameter for each five feet of length for hard coal. The best practice in spacing the tubes in the tube sheet is to leave an inch clear space between adjacent tubes and 3 ins. between the boiler shell and the nearest tubes at the sides, this space to be increased to 5 or 6 ins. at the bottom of the shell.

Table IV gives the horse-power and other data for different sizes of boiler. The number of tubes specified corresponds closely with that recommended by the leading insurance companies, but may be increased somewhat in special cases, if necessary, to secure a required heating surface within a given space. In such a case it is better, if possible, to select a larger shell and use the number of tubes specified in the table for that diameter. Two sizes of grate and smoke pipe are given for each boiler, one being computed for an evaporation of 9 lbs. of water per pound of coal, and the other for an evaporation of 8 lbs., which figures correspond to average practice in power and heating service, respectively. The width of the grate is usually made 6 ins. less than the diameter of the shell, while the length may be varied within certain limits to give the required grate surface. The length of the grate, however, should not exceed 6 ft. in hand-fired furnaces. Grates 4 ft. long and over should be made in two sections, so as to use short grate bars, which are less likely to warp than longer ones.

SIGHT-FEED CYLINDER LUBRICATORS.

BY JAMES F. HOBART.

A type of lubricator, which formerly was almost universally found in the engine room, but which the force-feed type is rapidly superseding, except in special classes of service, is the hydrostatic sight-feed lubricator, or the form in which the oil is displaced by steam condensation. Before describing this type of lubricator it may be well to point out that it does not work reliably when the steam-chest pressure is approximately equal to the boiler pressure. That is to say, with a difference of pressure between the connections of the lubricator, it works to advantage, but when there is little or no difference of pressure, then the oil seems to prefer to stay in the lubricator, rather than to flow out through the oil pipe. A remedy has been found for this defect by so arranging the steam piping and throttle that a portion of the steam is made to flow through the oil pipe, thus carrying the oil with it, but this complicates matters. Making the oil piping large helps matters wonderfully, and the provision of a considerable hydrostatic pressure is also good, but where the steam-chest pressure approximates boiler pressure, as in the higher types of engines, the "sight-feed" automatic lubricator does not work well.

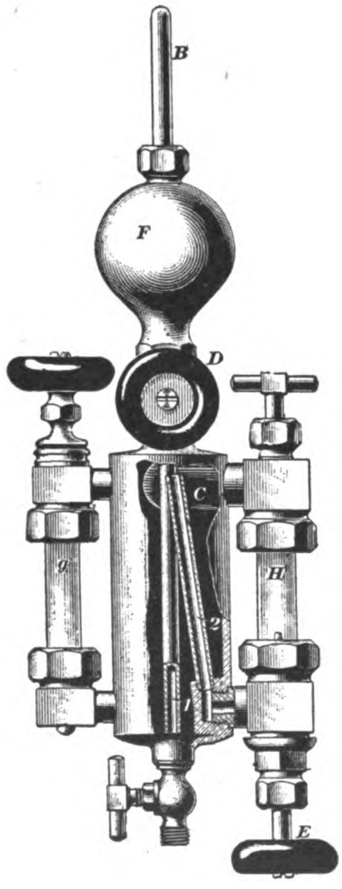

FIG. I.—DETROIT LUBRICATOR.

Fig. 1 illustrates the well-known hydrostatic lubricator made by the Detroit Lubricator Company. This is of the single-feed variety (they are made double and triple-feed). Steam comes through the pipe *B*, into the reservoir *F*, where the vapor is condensed, and when the valve *D* is opened, the water of condensation runs into the oil-containing chamber through the pipe 1. Steam also enters the pipe *C*, and the water of condensation fills the sight-feed glass *H*, if the valve *S* be opened, as it should be. Water in the glass *H* can rise no higher than the pipe *C*, for this pipe is in connection and level with the delivery pipe to cylinder; consequently any more water would simply run over into the steam pipe leading to the cylinder. But water can back up in the pipe *B*, as that is considerably higher than the level *C;* consequently if the valve *E* be opened, oil will be forced down the pipe *2* by the hydrostatic pressure of the water in the pipe *B*, and the oil will rise out of the nozzle at the bottom of the glass *H*, pass up through the water in the glass and find its way through the pipe *C*, into the steam pipe leading to the engine cylinder. By adjusting the valve *E*, any desired number of drops of oil per minute may be delivered, within the capacity of the lubricator.

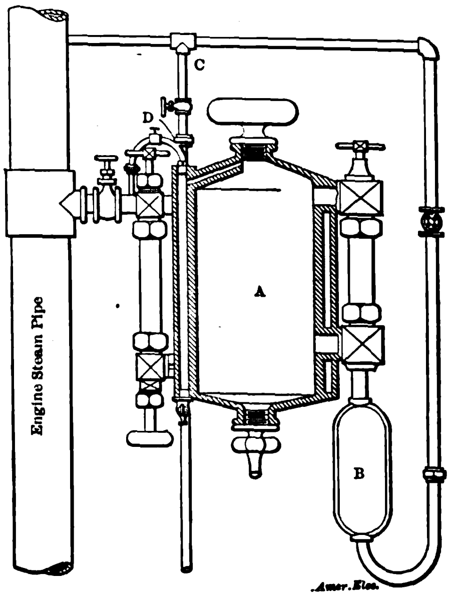

FIG. 2.—KEYSTONE LUBRICATOR.

The lubricator just described is known as the "single connection" type, to distinguish it from the type having two pipes connecting it with the engine steam pipe. The only difference is that the pipe *B* is carried direct to the engine steam pipe, instead of being taken from the top side of *C*. There is little choice between the working of the two types, but what slight difference there is seems to be in favor of the double connection lubricator. Many improvements have been made in these lubricators, one of especial importance being the carrying of the steam connection through which the oil is discharged, directly through the oil space, so that the oil is always warm and in condition to flow freely through the delivery nozzle into the sight-feed glass. This largely prevents the annoying adhering of oil to the glass which is sometimes so troublesome in cold weather. The "Zero" lubricator is thus constructed, and is consequently able to work in zero weather, or when exposed to storm and frost; hence its name.

One point should be called to the attention of every person using a lubricator, and that is that the lubricator should never be left with the water condensing pipe *B* closed when the engine is shut down. When this is done, particularly with the types where the oil is delivered to the engine above the throttle valve, there is a circulation of live steam through the oil delivery pipe into the oil-heating part of the lubricator. As a consequence, the oil and water contained therein are liable to become heated and to expand. If the water valve is closed, a tremendous pressure may be put upon the shell of the lubricator, the manufacturers stating that in some instances where a gauge has been connected for measuring this pressure, upwards of 1000 pounds per square inch was indicated by the gauge—a force much more than sufficient to distort the metal of the lubricator, start some of the connections, or otherwise injure it. If the water valve be left open and the oil delivery valve closed, this trouble will never occur.

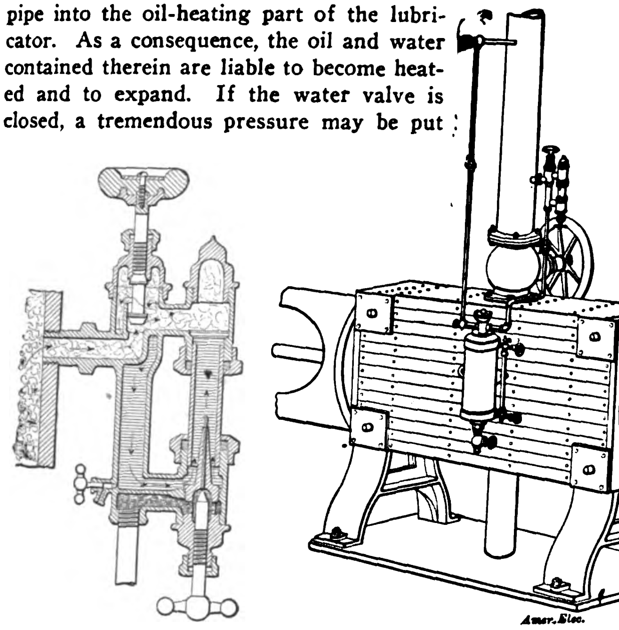

FIG. 3.—BABCOCK-KELLEY LUBRICATOR.

Double and triple lubricators are made for taking care of the several cylinders of compound engines. In these lubricators, there is no connection between the several sight feeds, and equalizing pipes are provided for each sight feed to carry the drop of oil to its cylinder as soon as it rises through the sight-feed glass. Either feed may be shut off without disturbing the other.

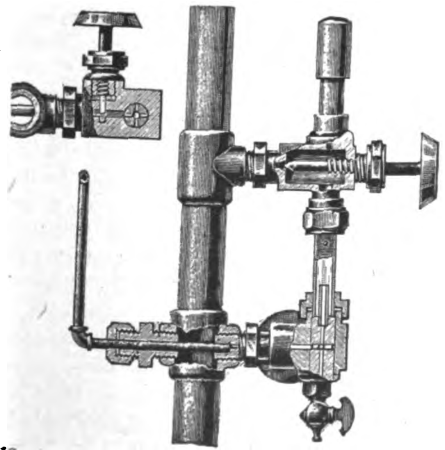

FIG. 4.—LUBRICATOR USING HEAVY CYLINDER OIL.

Fig. 2 shows a type of heated lubricator which is the opposite of the usual design, inasmuch as the reservoir is jacketed with live steam instead of having the heating done by steam enclosed in the delivery pipe. This lubricator is known as the Keystone, and is made by G. L. Brisbane, McKeesport, Pa. A branch is taken from the condensation supply pipe and carried to the jacketing chamber at *C*, and a by-pass, *D*, can be used for the jacket supply should the pipe *C* become broken. The action of the lubricator is much the same as the one already described, but in this form the condensing chamber, *B*, is not located above the cup as is usual. Placed in the position shown, it acts as an expansion chamber, receiving the overflow of oil from the main cup, *A*, as the contents thereof become heated to nearly the temperature of the steam in the engine pipe. Under such circumstances, there must be considerable expansion of the oil contained in the cup, but the chamber *B* will take care of it, and return the surplus oil to the reservoir after sufficient oil has been fed into the steam pipe to make room for the surplus.

A form of lubricator in which the oil is heated only as fast as it is to be used and only to 212°, is shown by Fig. 3, and is known as the Babcock-Kelley lubricator. In the engraving the small cut shows the construction of the oil-heating and delivery device and the larger cut shows the application of the lubricator to an engine. It is stated that the oil-containing vessel may be placed at any convenient point, away from the discharging and heating devices, even beneath the floor, and the lubricating mechanism alone located on the steam pipe where space is often at a premium. In the engraving the lubricating device is shown attached above the throttle valve, while the oil-containing cylinder is located conveniently on the side of the engine cylinder within reach of the engineer. A condensation pipe is carried to the oil reservoir, and an oil pipe leads to the distributor, entering it through the broken pipe at the bottom of the small cut.

As the oil enters the delivery device it encounters the thin metal partition shown, on the other side of which is hot water condensed from the supply of live steam shown in the upper part of the cut as coming from the steam pipe at the left. The steam enters, flows according to the arrows, and is condensed more or less quickly, and then flows as water in the U-shaped passage as indicated by the vertical arrows, passing the thin oil-heating partition, and then surrounding and passing upwards alongside the oil-discharge nozzle. Thus the oil as it approaches the regulating valve, is heated, and then discharged into a stream of hot water already flowing in the direction the oil is to take, which causes the oil to pass off into the steam pipe without lodging against the sight feed glass. The oil is thus positively discharged into the steam in the engine supply pipe. This lubricator is manufactured by the Crescent Oil & Supply Company, St. Louis, Mo.

In cases where a very heavy cylinder oil has to be fed, and it is necessary to thoroughly heat the oil, the lubricator shown by Fig. 4, made by Henry C. Roller, New Castle, Del., may be employed. In this arrangement the oil tank is located anywhere convenient and connected to the broken pipe shown at the left, which passes directly through the main steam pipe, so as to heat the oil as it flows to the lubricator. The oil tank is under steam pressure, and if it is located above the lubricator, the oil feeds directly by hydrostatic pressure due to the weight of the column of oil; if the tank is below the lubricator, then water displacement feeds the oil in the usual manner.

Steam entering the upper casing is condensed and fills the sight-feed glass. The short closed pipe above the glass answers for a condensing chamber, and always maintains a sufficient supply of water in the glass, through which the oil rises in the usual way from the regulating valve nozzle. If desired, the oil can be fed downward by merely reversing the positions of the two casings. Then, the drops of oil will fall from the nozzle into water which fills what is ordinarily the condensing chamber, but which becomes a mere water receptacle when inverted. From the water the oil flows into the steam pipe by gravity.

A very novel form of lubricator, which although classed as hydrostatic, is more truly a force-feed device, is illustrated by Fig. 5. This apparatus is manufactured by the Force Feed Lubricating Company, Milwaukee, Wis., and is one of the line of "Milwaukee" lubricators. Like the Milwaukee straight force-feed lubricator described in last month's article, this device

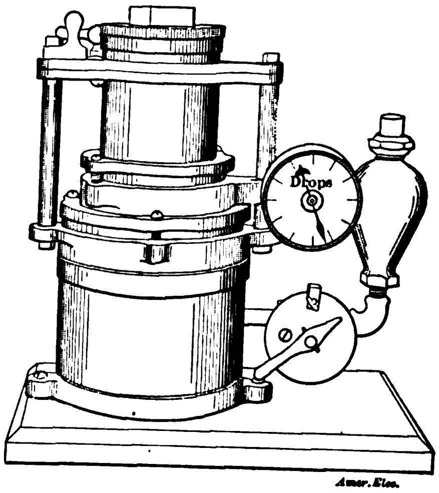

FIG. 5.—FORCE FEED LUBRICATOR.

is made to feed a certain proprietary lubricant, although it will handle any kind of oil or grease. The lubricator contains two plungers, or pistons, one twice as great in area as the other and subjected to steam pressure beneath it. The other, or upper plunger, carries the lubricant above it, and forces it into the steam pipe through a pipe provided for that purpose. Thus this machine is virtually a steam pump, capable of making a single stroke, the speed of which, if such a slow motion can be said to have "speed," is regulated by the valve lever shown at the right of the lower cylinder. By means of this lever, the amount of water entering the cylinder is throttled as desired until the requisite number of drops of lubricant are delivered per minute. The dial and hand above the valve denote the amount of lubricant fed, the graduations of the dial reading directly in drops. By timing the delivery with a watch, the amount of feed is readily determined.

When the oil chamber is empty, the screw plug at the top is removed and with a special lever made for that purpose the plungers are forced to the bottom of their cylinders again, and another supply of lubricant is put in, after which the plug is replaced, and the lubricator is ready for another run. For a forced feed, where it is not practicable to attach a working rod, this device proves most excellent. It is entirely self-contained, and there are no rods to be in the way or to break, so that it is commendable for vehicle and boat service, as well as stationary practice.

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SOME TELEPHONE WRINKLES.

BY J. W. STRIPPEL.

In the article by the writer which was published in the August number of the AMERICAN ELECTRICIAN under the above head, mention was made of an arrangement whereby a telephone subscriber could obtain both office and residence service while subscribing only for a single instrument. The diagram illustrating this arrangement, however, was omitted, and is therefore given herewith. The office telephone set is connected to an ordinary two-wire plug, *P*, and two spring jacks, *R* and *E*, are provided, into either of which this plug may be inserted. With the plug inserted in the jack *R*, the residence instrument and the office instrument are connected together, leaving only the bridging bell, *B*, connected to the exchange circuit. With the plug inserted in the jack *E*, the office instrument is connected to the exchange wires, and the residence line terminates at the bridging bell, *B*. With the plug removed, as shown in the diagram, the residence instrument is connected straight through to the exchange.

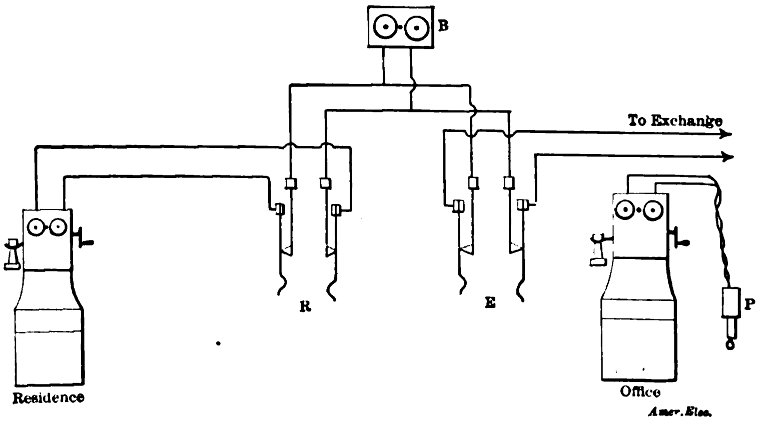

FIG. 1.—CONNECTIONS FOR OFFICE AND RESIDENCE LINE.

The provision of the bridging bell, *B*, enables the exchange to call up the office when the office instrument is connected to the residence line, and also enables the residence to call up the office when the office instrument is connected to the exchange line. The plug would be withdrawn from the jacks, leaving the residence connected through to the exchange, only over night and during such other periods as the office might be closed.

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PROTECTION OF TRANSFORMERS.

Several questions as to the protection of transformers were discussed from a practical standpoint at the last National Electric Light Convention. One of these was, "What method of protection should be used when transformers are operated with interconnected secondaries to prevent a short-circuit at one point from blowing the fuses on all the transformers feeding the connected network?"

Mr. H. H. Scott, of Lincoln, Neb., advocated the use of fuse junction boxes on secondaries, electrically midway between transformers, the size of the fuse depending on how much one wishes to overload any one transformer. Mr. W. T. Oviatt, of the Connecticut Ry. & Lighting Company, suggested the division of the secondaries into sections by fuses of small ampere capacity placed at points where they will carry small currents, except in cases of short-circuits. Mr. C. R. Maunsell said his company, the Topeka (Kan.) Edison Company, uses the same plan of interconnecting transformer secondaries that it uses on the mains of the three-wire Edison system, and has never had any difficulty in short-circuits blowing fuses in any section besides the one wherein the trouble existed.

Mr. L. G. Van Ness, of St. Paul, Minn., replied to the question as follows: If secondaries from several transformers are interconnected, fuses must be inserted at the electrically middle point between transformers to prevent trouble at one point from extending over the entire network. The carrying capacity of these fuses will depend on the size of the transformers, the cross-section of the secondary wires, and the distance between transformers. They must be large enough to allow one transformer to help out its neighbor in case of overload at one point, but they must also be light enough so that a short-circuit at any point on the net-work will blow the junction fuses before the primary fuses on next adjacent transformers give way. This will isolate the defective transformer and its secondary system, and will not throw out the entire net-work.

One may not be able to select a size of junction fuse that will blow at exactly the proper time for all conditions of load, but it may be approximated by slight changes in the primary fuses to accommodate certain conditions. Suppose it is desired that a transformer shall be able to send half its output to the next district; then the junction fuses would be half the current capacity of the transformers and in case of a short-circuit, with full load equally distributed, the primary of the affected transformer would blow, and each transformer would send current to the defective district. If the cross-section of the secondary circuit-wires is ample and the distance not excessive, the resistance of the short-circuit will be very low compared with the normal secondary circuit through the lamps and the greater portion of the current will tend to flow through the junction fuses, thereby blowing it before the primary fuse goes. This is the result that would naturally be expected, but experience shows that this does not always occur with transformers fused to their rated capacity, probably for the reason that the primary fuse is already warm from carrying normal load and the junction fuse is cold at the time the trouble occurs.

If we expect the junction fuses to carry half the normal load of the transformers, the primaries of the transformers must be fused slightly above rated capacity in order that trouble may not extend beyond one district. If we can distribute transformers so that it is not necessary for them to send more than one-fourth or one-third of their rated load to the adjacent districts, it is usually safe to fuse primaries to their rated capacity. For an interchange of load for more than one-third of the rated capacity of the transformers, I think that primaries should be fused slightly above the normal capacity of the transformers, in order that junction fuses may do their work properly. This is not likely to cause any damage to the transformers, as short circuits will blow very heavy primary fuses before any damage is done to the transformer.

Mr. H. B. Gear, of the Chicago Edison Company, said that the protection of interconnected secondary systems is a problem which can only be satisfactorily solved in particular cases, as there are too many local conditions entering in to make it possible to lay down general rules: In cases where the load is comparatively dense, a carefully designed system of fuses so placed that a section of the secondary system will be cut out in case of serious trouble, is probably the best method of protection. In residence districts or similar territory where the load is not so dense, it has been found preferable in Chicago to allow each transformer to feed its own secondary without interconnection on the secondary side.

Mr. E. J. Bechtel, of Toledo, Ohio, said that his company has several interconnected secondaries upon which are operated different numbers of transformers. There is no protection between the secondary coils of the transformers and the secondary mains; the only protection being the junction fuse on the primary side, fused for 150 per cent. of the transformer capacity. From this company's experience, trouble is so infrequent as not to necessitate other protection.

Mr. Leonard Andrews, of Hastings, Eng., said this is a question in which he has taken considerable interest. In the system at Hastings, Eng., the low tension network is connected together and fed by transformer sub-stations at various points in the town. It has been found useless to attempt to put fuses in any place in the low tension network, as a failing transformer invariably short-circuits the network without blowing the fuse between that and the network, and blows a number of fuses in other places, often cutting off the supply to the whole district. Between the secondaries of the transformers and the low tension net-work return current, cut-outs are used which only operate when a transformer ceases to supply energy to the network, and receives energy from the network. All of the transformers are equipped in this manner, and there is not the slightest hesitation in short-circuiting either the primary or secondary winding of the transformer connected to the network at any time, as the automatic return-current cut-outs can invariably be relied upon to disconnect the faulty apparatus.

SOME "HORRIBLE EXAMPLES."

BY BENJAMIN H. GLOVER.

Comparatively a few years ago it was not an uncommon thing to find home-made electrical fittings and appliances. These were usually designed for some special work and served their purpose in a more or less satisfactory manner. Some of these creations display no small amount of ingenuity and illustrate emphatically the inventive ability of their constructors. Even at this day of advanced progress a quantity of antiquated apparatus and material is still doing active service in its own way, though generally unreliable and inefficient.

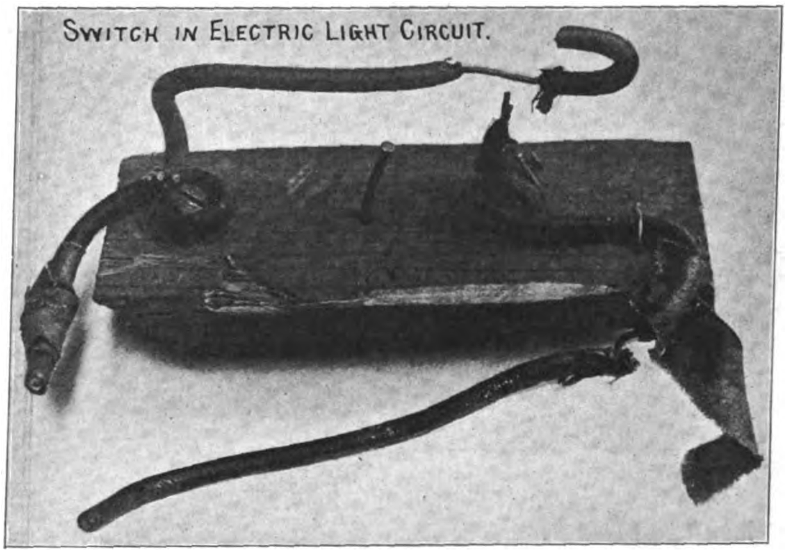

FIG. 1.—ARRANGEMENT FOR CONTROLLING INCANDESCENT LAMPS.

In the matter of switches, as ordinarily used for making or breaking circuits of small capacity, one would hardly think it likely that any but standard goods would be used, especially when they can readily be obtained anywhere at a cost of a few cents; but to show that this is not always the case is the purpose of this article, by giving illustrations and descriptions of some switches which have been found actually in use.

In Fig. 1 is shown an arrangement found controlling a number of incandescent lights in a large mercantile establishment. The bare surfaces of the wires, the nailed and screwed fastenings, the poorly made joints and the loose and frayed coverings all combine to make a hazardous condition of affairs, to say nothing of the method of contact itself. It seems almost incomprehensible that such a device could be used in an establishment where stock and property of large value were endangered and where crowds of shoppers were constantly moving about.

A home-made switch constructed by the "engineer" in charge of the plant of a hotel building is shown in Fig. 2. This switch consists of a porcelain rosette-base, to which is attached a piece of strap iron having a wooden handle. The terminals of the rosette lying flush with the porcelain surface, a reliable contact with the rough switch arm was impossible, and indications of overheating and arcing were noticeable. The load on this switch was twelve 16-c.p. 110-volt lamps.

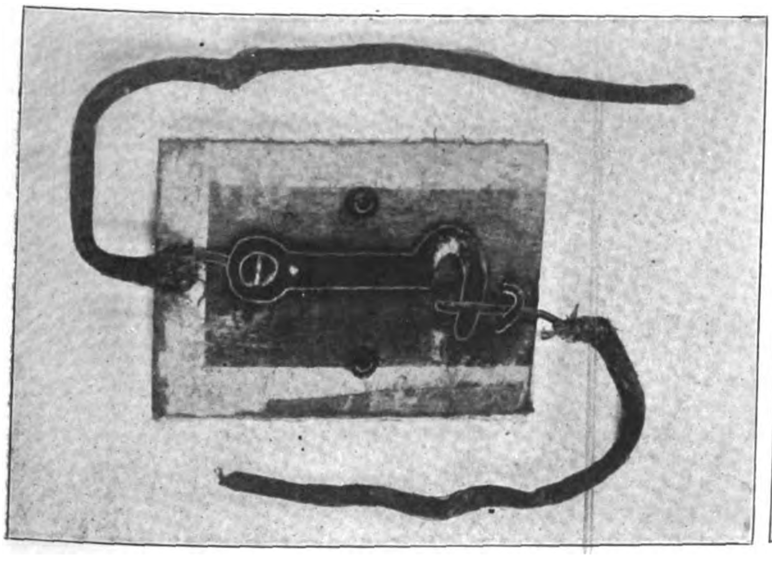

FIG. 3.—ANOTHER FORM OF SWITCH.

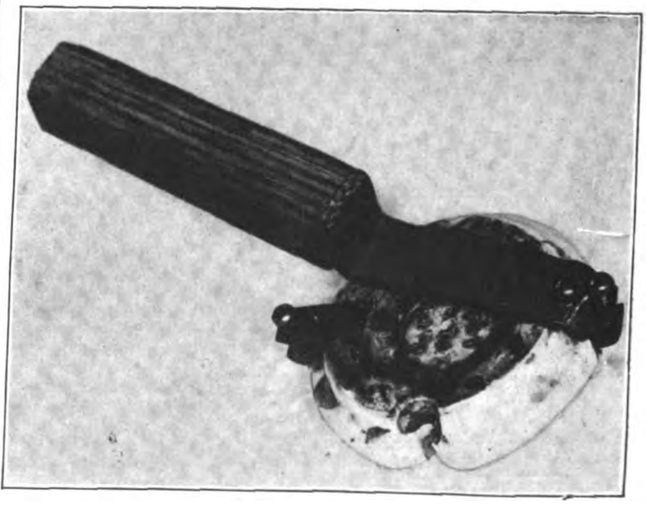

FIG. 2.—HOME-MADE SWITCH.

In Fig. 3 is a remarkable example of simplicity, which speaks for itself. A flat brass hook engaged a loop bent at the end

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New Water-wheel Governor.—On page 410 of the August number a mix-up in the last five lines makes that portion of the article unintelligible. The first and second lines of these five should be the last lines of the page.

of the line wire and was installed so that gravity tended to keep the switch closed. This switch was also found in a large mercantile establishment, being located in the basement and used to control a circuit of five 16-c. p. 52-volt lamps.

The last specimen shown in Fig. 4 is somewhat complicated and indicates that the constructor had the idea of what was wanted and used the means at hand to accomplish the desired end. This switch was fitted to a portable lamp by an "electrician" to allow the light to be turned on and off. The material entering into the "switch" consists of a brass back, to which is soldered parts of a suspender buckle, through which a lamp-wick carrying the movable contact is made to slide by pulling the strings at the top or bottom. The two fixed contacts are secured to a semi-circular piece of fiber, which might have originally belonged to a thermostat. It should be stated that this switch was afterwards replaced by an ordinary key socket.

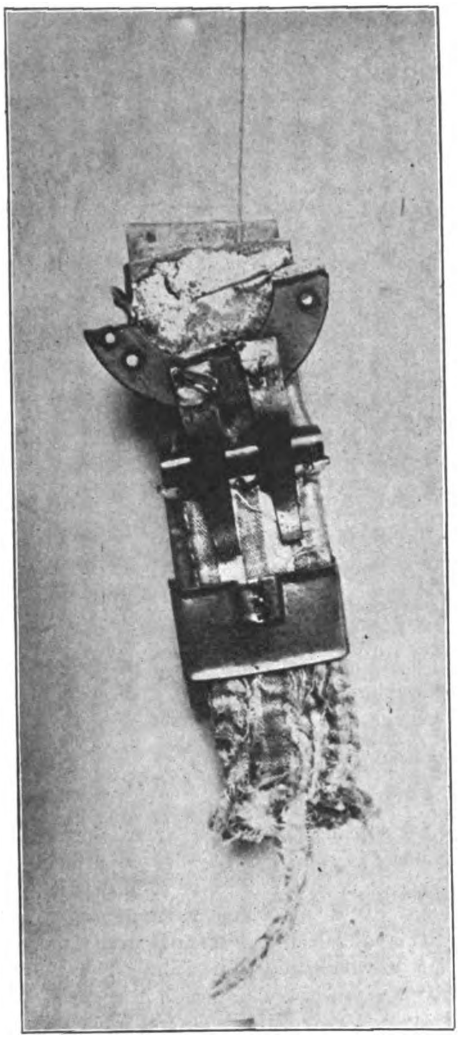


FIG. 4.—SWITCH.

Lessons in Practical Electricity

THE ELECTRIC MOTOR.

The ordinary electric motor is substantially identical in construction with the dynamo; the one is merely an inversion of the other, the function of the dynamo being the conversion of mechanical energy into electrical energy while the motor converts electrical energy into mechanical energy.

It was explained in the April (1902) Lesson that if a loop of wire or other conducting material be located as shown in Fig. 1, so that it surrounds the magnetic field in an air gap between the poles of a magnet, any attempt to pull the loop out of the position shown will cause some part of the wire to "cut" the magnetic flux and induce an e.m.f. in the loop. This in turn will force current through the loop and cause a magnetic pull between the flux and the loop, in opposition to the effort made to displace the loop from its flux-enclosing position. The reverse of this is also true, and forms the principle underlying the operation of the electric motor. If the loop be opened at the ends, so that current may be introduced into it from an external source, and then its position be changed to one unsymmetrical with the magnetic field, as indicated in Fig. 2, the passage of current through it will cause it to be either drawn into the position of Fig. 1 or forced out of the magnetic field, according to the direction in which the current flows through the wire. With current flowing as indicated by the arrows in Fig. 2, the loop would be pulled up into the position shown by Fig. 1, the polarity of the magnet being as indicated by the letters, *N*, *S*.

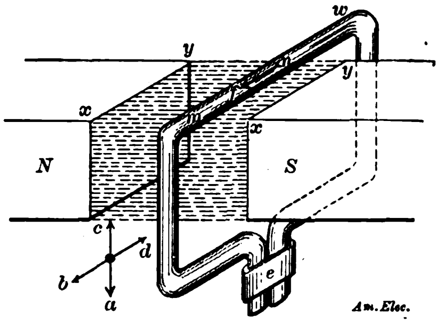


FIG. 1.

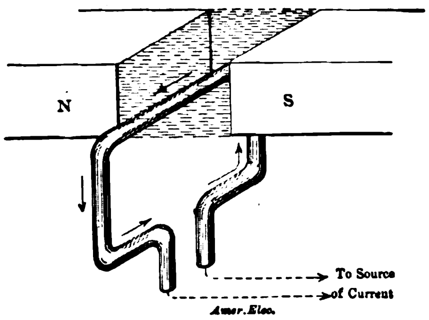


FIG. 2.

As in the case of the dynamo, continuous motion by the movable current-carrying loops or coils of a motor is obtained by arranging them so that they can rotate within the magnetic field. Fig. 3 shows a coil of two convolutions connected to two commutator segments and Figs. 4 to 7 show single loops similarly connected and occupying different positions in a magnetic field. In Figs. 5, 6 and 7 the brushes are omitted for the sake of clearness, their points of contact with the commutator being indicated by the arrow-heads lettered to correspond. At *d*, two arrow-heads are shown, to indicate the points of contact at both the front and back ends of the commutator.

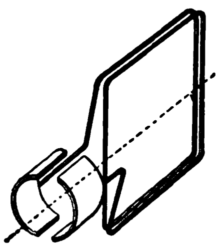


FIG. 3.

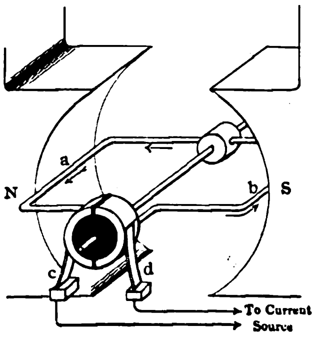


FIG. 4.

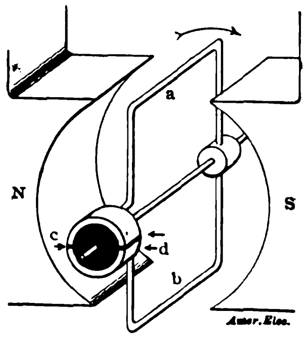


FIG. 5.

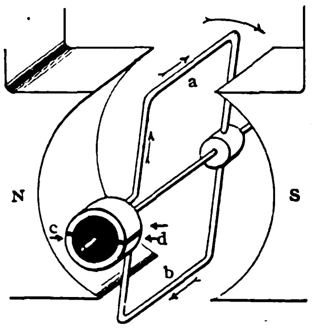


FIG. 6.

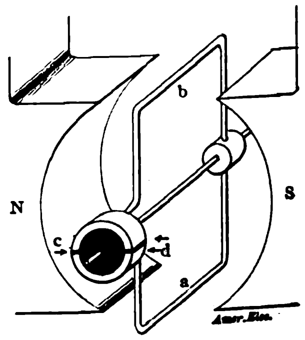


FIG. 7.

If current be passed through the loop when it is in the position shown in Fig. 4, it will be immediately pulled around to the position shown in Fig. 5. Reaching this position, the brushes *c* and *d* touch both commutator segments, and the current passes from brush to brush through the segments instead of through the loop. The momentum of the latter, however, will carry it past this "dead center," and the instant that is done, the current will flow through the loop in the opposite direction, as shown in Fig. 6, and the loop will be drawn by the magnetic field around through a half revolution to the position shown by Fig 7, which is 180° from that shown in Fig. 5. Here the commutator reverses the current in the loop again, so that it is drawn on around to the position shown in Fig. 5 again, and so on, as long as current is supplied to the loop and the magnetic field is maintained.

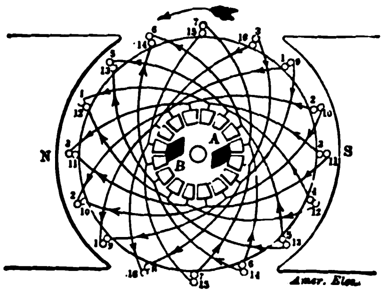


FIG. 8.

The movable part, or armature, of a motor is exactly like that of a dynamo, consisting of a cylindrical iron core on which a large number of current-carrying loops are mounted. In an actual machine, therefore, every time the brushes pass from one commutator segment to the next, the direction of the current through the coil connected to those two segements is reversed. An analysis of the armature circuits will show that this occurs always when the coil has reached a position where there is no longer any pull or "torque" between the magnetic field flux and the current in the coil. Fig. 8 is a diagram of a 16-coil armature having only one turn per coil, like the loop of Figs. 4 to 7, the brushes, *A*, *B*, being represented as located inside the commutator barrel in order to avoid obscuring the connections of the winding. The disposition of each pair of coincident coils is as indicated in Fig. 9.

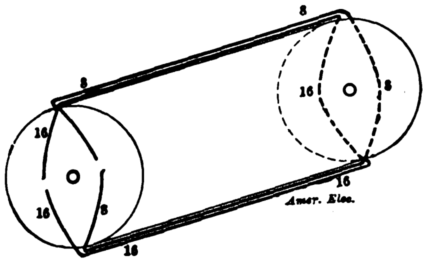


FIG. 9.

Assuming that current enters the armature at the brush *B* and returns to its source from the brush *A*, Fig. 8, the armature will revolve in the direction indicated by the large arrow above it, and the path of the current through the winding will be as indicated by the small arrow-heads on the commutator connections. It will be obvious that the current in all of the wires on the left-hand half of the armature periphery will flow from front to back—away from the observer—while the current in all the wires on the other half will flow towards the observer. This direction of flow is opposite to that indicated in Figs. 4 to 7; consequently the armature will revolve oppositely to the direction of the loop in the latter diagrams. As fast as a coil reaches the position occupied by Nos. 7 and 15 in Fig. 8, it is cut out of circuit and when it is restored again, on the other side of the "dead" line, the current flows through it in the opposite direction (see Fig. 10, which shows the armature after passing through $^1/_{16}$ of a revolution from the position in Fig. 8). Consequently, in the case here assumed, the current always flows from front to back in all wires on the left-hand half and from back to front in all wires on the right-hand half of the armature periphery, no matter which wires may constitute these two groups; the result is a continuous torque between the magnetic field and the armature wires, always in the same direction, rotatively.

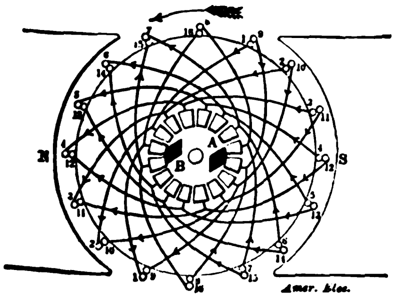


FIG. 10.

The actual pull or torque exerted by the magnetic field upon each wire of a motor armature is given by the formula

$$\frac{B\,l\,i}{11{,}302{,}363} = \text{Torque per wire....(1)}$$

in which *B* is the average density of the magnetic field in lines of force per square inch; *l* is the length of the armature core parallel with the shaft, and *i* is the current carried by each wire (in a two-pole machine, one-half of the current entering at the brush). The total torque exerted, therefore, will be

$$\frac{B\,l\,w\,i}{11{,}302{,}363} = \text{Torque in pounds....(2)}$$

in which formula *w* represents the total number of wires all around the circumference of the armature.

Letters on Practical Subjects

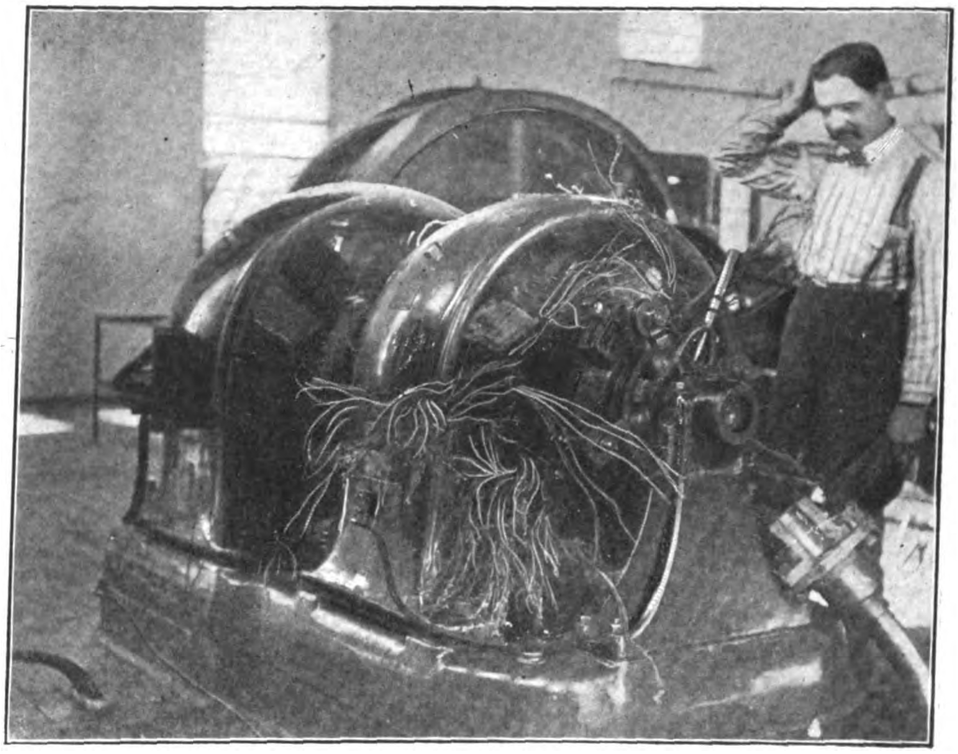
A Bad Wreck.

To the Editor, American Electrician:—

I send herewith a photograph of a motor-generator, which was wrecked as a result of damage by lightning. The photograph does not portray the wreck as complete as it actually is. The center bearing between the motor and the dynamo was wrenched from the base and broken into several pieces, some of which were hurled through the engine room floor. The shafts were both broken off close to the two armatures; a section of one shaft is shown in the foreground. Every wire was broken from the commutator of the motor armature, and the field coils were badly damaged. This outfit was used in connection with storage batteries in an interurban railway power house, the motor being driven directly from the bus-bars.

O. H. HUTCHINGS.

Dayton, Ohio.



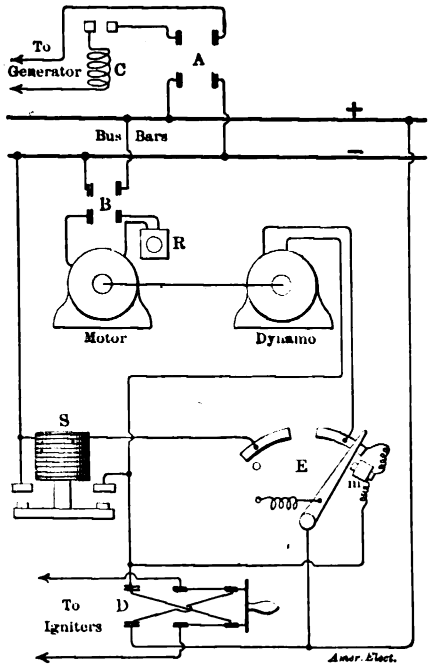
MOTOR-GENERATOR WRECKED BY LIGHTNING.

◆◆◆

A Motor-Dynamo Trouble.

To the Editor, American Electrician:—

In a letter published in the July number of the AMERICAN ELECTRICIAN, headed "A Motor-Dynamo Trouble," Mr. Chas. D. Story asks for an explanation of what he terms an unusual action of a small motor-generator set. From an inspection of the diagram accompanying that article, it would appear that there could be no reason why the motor should reverse. This diagram, of course, cannot show what action takes place inside the motor when the circuit-breaker is closed. At the moment the circuit-breaker is closed, there being very little resistance in the armature circuit, a large current rushes instantaneously through the armature windings, while in the field coils, on account of their high self-induction, there is at first only a slight current, which requires time to reach its maximum. Now, the brushes on the motor having a backward lead, this armature current magnetizes the field poles in the opposite direction to that which the field coils tend to magnetize them. We know that if the fields of a shunt motor are reversed, and the armature connections remain the same, the direction of rotation will be reversed; and this is what will happen in the above case. The motor will run at a much higher speed, and spark badly, because this resultant field is weaker than the normal field strength. If the brushes of the motor have a forward lead, this reversal of direction will not occur, because in this case the induced magnetism strengthens the magnetism due the field coils. When the starting box is used, this cuts down the starting current, and gives the field time to become fully charged before the resistance of the box is cut out.


To Generator
C
A
+
−
Bus Bars
B
R
Motor
Dynamo
S
E
m
To Igniters
D
Amer. Elect.

MOTOR-DYNAMO CONNECTIONS.

Philadelphia, Pa.

GUY STRAFER.

◆

Mr. Cummings' Problem in Electric Light Switch Connections.

To the Editor, American Electrician:—

Herewith is a sketch of wiring (Fig. 1) offered as a solution of the problem by Mr. E. W. D. Cummings, published in the August number. All of the switches for control from two points are of the usual two-way or so-called three-point type. The diagram is self-explanatory.

H. B. BROWN.

Schenectady, N. Y.

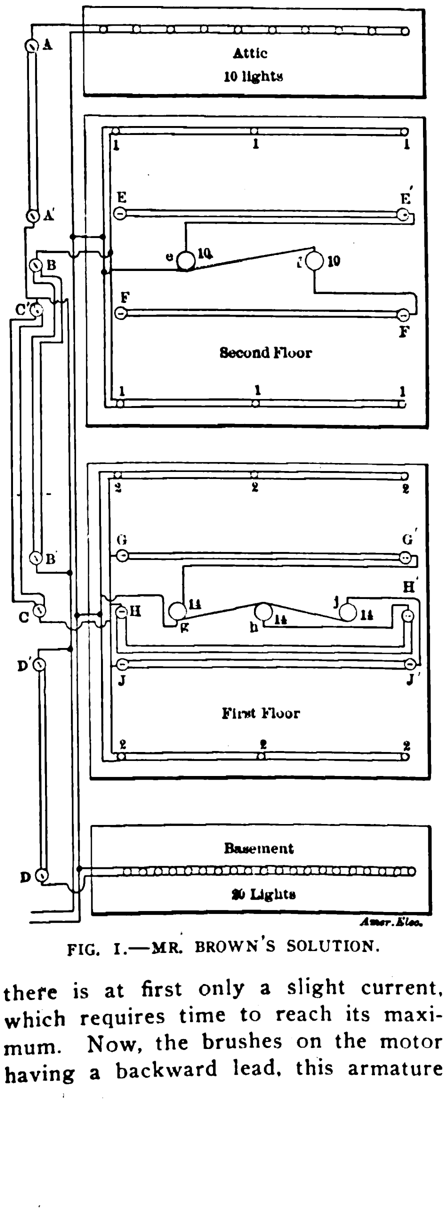

A
Attic
10 lights
A'
B
C'
1
E
E'
e
10
f
10
F
F
Second Floor
2
G
G'
H
H'
g
h
j
11
J
J'
First Floor
B
C
D'
Basement
20 Lights
D
Amer. Elec.

FIG. 1.—MR. BROWN'S SOLUTION.

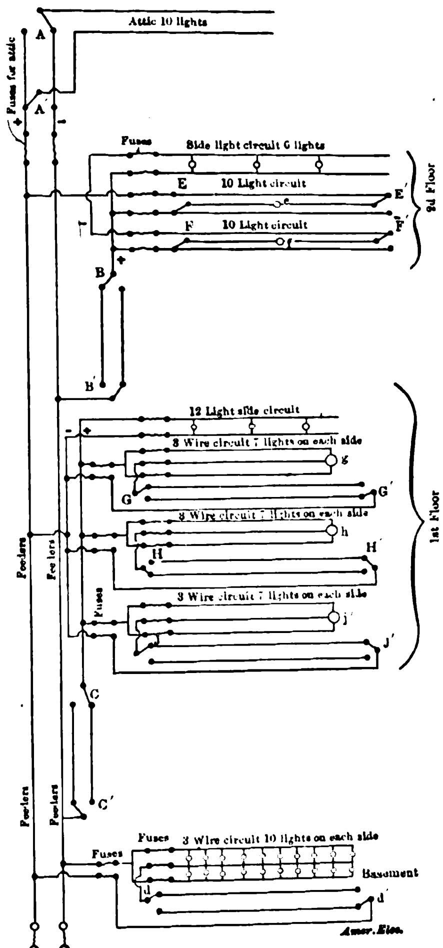

Attic 10 lights
Fuses for attic
A
A'
Fuses
Side light circuit 6 lights
E
10 Light circuit
e
E'
F
10 Light circuit
f
F'
2d Floor
B
B'
12 Light side circuit
3 Wire circuit 7 lights on each side
g
G
G'
3 Wire circuit 7 lights on each side
h
H
H'
3 Wire circuit 7 lights on each side
j
J'
1st Floor
Feeders
Fuses
C
C'
Fuses 3 Wire circuit 10 lights on each side
Basement
d
d'
Amer. Elec.

FIG. 2.—MR. BURNHAM'S SOLUTION.

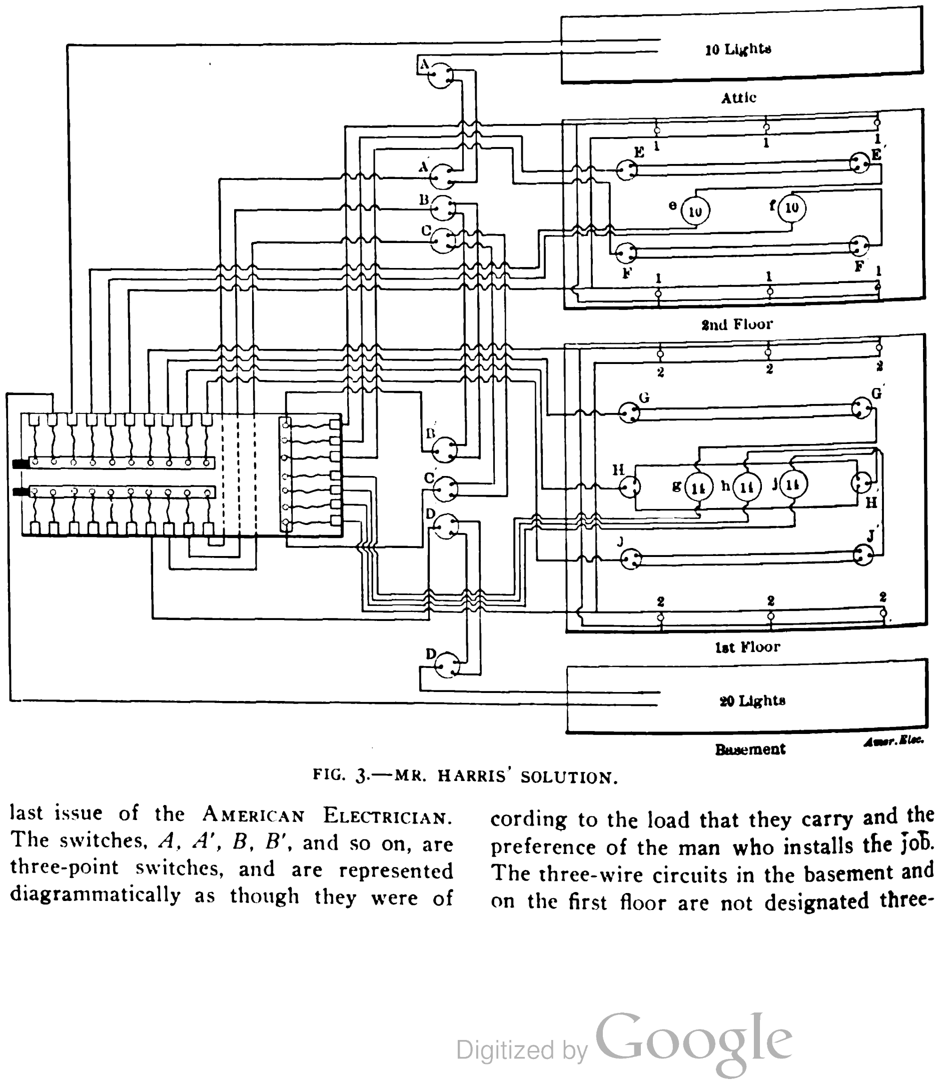

10 Lights
Attic
A
A'
B
C
E
1
E'
e
10
f
10
F
F
2nd Floor
2
G
G'
H
g
11
h
11
j
11
H
J
J'
B'
C'
D
1st Floor
D'
20 Lights
Basement
Amer. Elec.

FIG. 3.—MR. HARRIS' SOLUTION.

To the Editor, American Electrician:—

I send herewith a diagram of wiring (Fig. 2), which fulfils the conditions of Mr. Cummings' problem published in the last issue of the AMERICAN ELECTRICIAN. The switches, *A*, *A'*, *B*, *B'*, and so on, are three-point switches, and are represented diagrammatically as though they were of the common strap variety; this, of course, is not intended to be taken literally. The switches may be either snap switches or double-pole single-throw knife switches, according to the load that they carry and the preference of the man who installs the job. The three-wire circuits in the basement and on the first floor are not designated three-

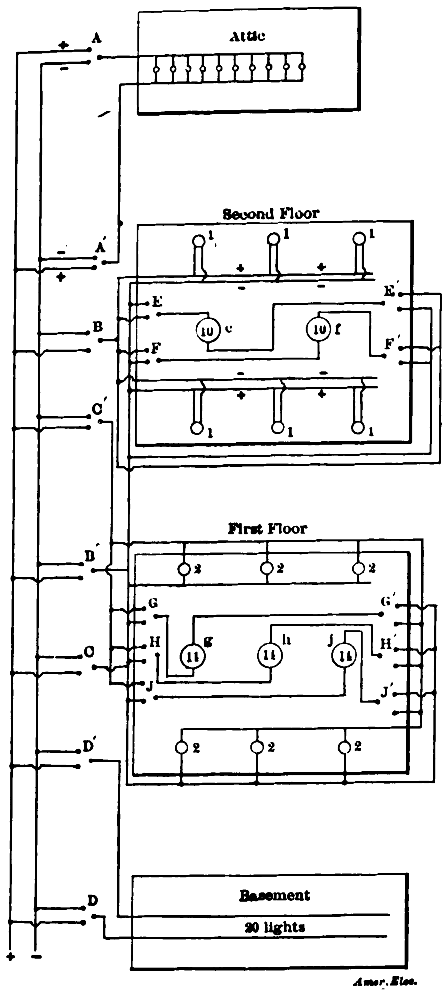


FIG. 5.—MR. KNOWLTON'S SOLUTION.

wire in the usual sense of that term. The lights at each outlet are divided into two groups, and these groups are connected to individual wires on one side of the circuit, and to a common-return wire on the other side, which leads to the three-point switches. The lamps in the basement are shown connected up singly, merely in order to indicate the division of the lights into two groups.

GEO. A. BURNHAM.

Winchendon, Mass.

To the Editor, American Electrician:—

Enclosed please find a diagram (Fig. 3) offered as a solution to Mr. Cummings' problem, which was published in the August number of the AMERICAN ELECTRICIAN. Although the diagram is practicaly self-explanatory to anyone who is familiar with wiring plans, it may be well to explain that the auxiliary bank of fuses at the right-hand end of the tablet board are provided in order to protect the special switching circuits required by the double-station control, in addition to the protection given by the regular fuses to the various circuits. All of the switches, *A*, *A'*, *B*, *B'*, etc., used for double-station control are of the two-way or three-point type commonly used for that purpose. No arrangement of lamps is shown in the attic or the basement for the reason that the author did not specify any particular arrangement.

FRANK HARRIS.

Sackville, N. B.

To the Editor, American Electrician:—

I enclose herewith a solution (Fig. 4) to Mr. Cummings' problem in lamp wiring, which was published in the August number. The sketch has been hastily made and may, therefore, require some explanation. The switches are all double-pole double-throw, the dotted cross-bars being intended to indicate mechanical connections between the two movable blades of each switch. It is, of course, understood that all of the switches must be either to one extreme or the other of their throw, and never left midway between the two contacts. The switches may be either of the snap or knife-blade pattern.

C. F. HUTTON.

Norris, Mont.

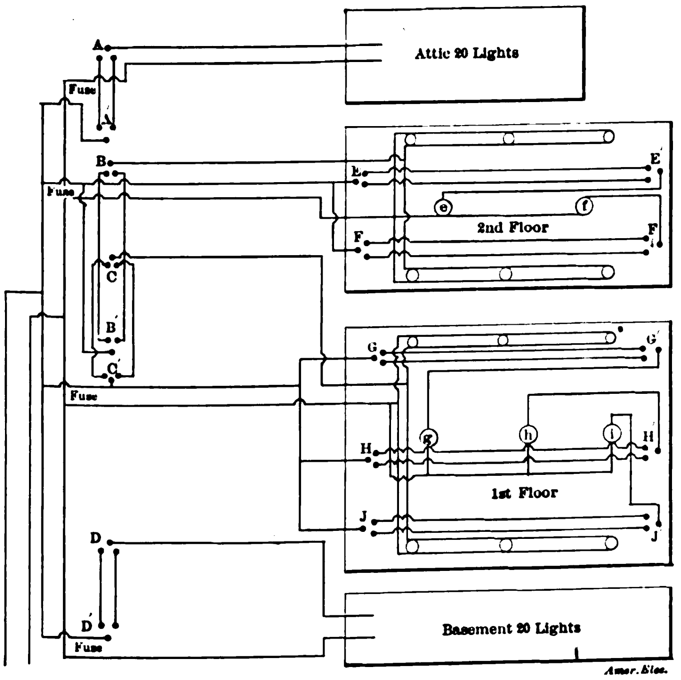


FIG. 6.—MR. LOHMAN'S SOLUTION.

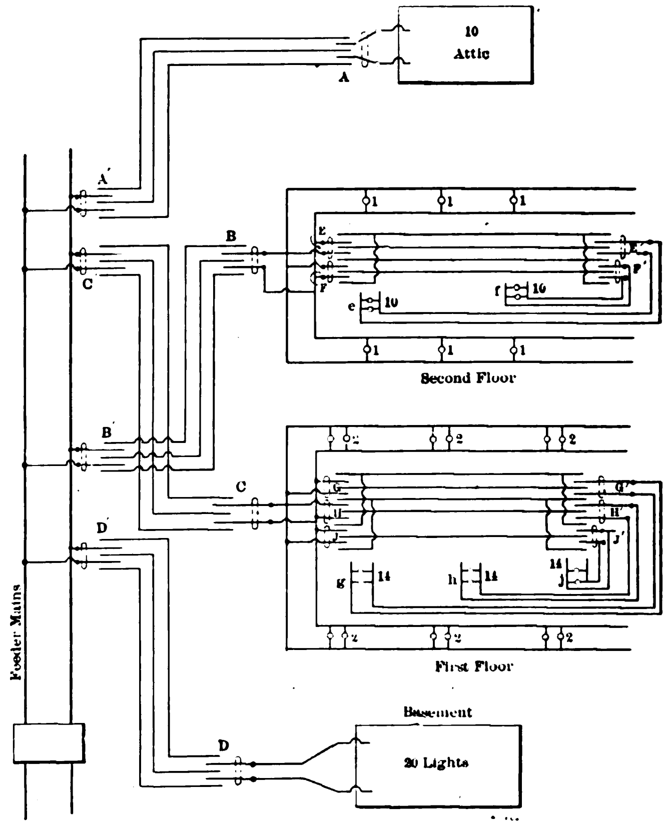


FIG. 4.—MR. HUTTON'S SOLUTION.

To the Editor, American Electrician:—

I enclose a diagram (Fig. 5) which I think supplies a solution of Mr. Cummings' problem in lamp control published in the last issue of the AMERICAN ELECTRICIAN. The switches, *A*, *A'*, *B*, *B'*, etc., are represented merely by three dots, but they are intended to be single-pole double-throw switches of either the knife-blade or snap variety. The double-station control is obtained by a somewhat unusual arrangement of the switches in order to reduce the number of wires as far as possible. Instead of connecting one side of each circuit permanently to the feeder and putting both switches in the other side of the circuit, I have put one switch in each side of each distributing circuit, so as to avoid running two wires between each pair of switches.

FRED KNOWLTON.

Ashland, Wis.

To the Editor, American Electrician:—

The accompanying diagram (Fig. 6) shows one method of solving the problem in lamp connections offered by Mr. E. W. D. Cummings in the August number of this paper. The switches, *A*, *B*, *C*, etc., are ordinary three-point switches of either knife-blade or snap construction, according to the load and the preference of the contractor. Double-station control is obtained in the ordinary way by inserting two switches in one side of each distributing main, and connecting the two switches by a pair of wires. The supply feeder is shown, carried up to the level of the second floor and tapped into the sub-feeder, from which the distributing circuits are taken; but, of course, if the distance is sufficiently short, this feeder can be attached to the lower end of the sub-feeder, so as to have only a single pair of feeder wires running from the basement to the attic.

F. H. Lohman.

Denver, Colo.

To the Editor, American Electrician:—

The accompanying sketch (Fig. 7) is offered as a solution of Mr. Cummings' problem in electric light wiring which was published in the August number. The supply main, which is of No. 4 wire, is carried up to the second floor, where the size is changed to No. 14 for the extension main up to the attic, a cut-out being inserted on account of the change in the size of the wire. Double-station control is obtained by means of three-way snap switches and double-throw single-pole knife-blade switches, the switches *A, A', B, B', C, C', D,* and *D'*, being of the latter type. Tablet boards are provided at each floor, as indicated, and the lights on the first and second floor are divided into four and three groups, respectively, at the tablet boards. This arrangement is intended for 16-c.p. lamps on a two-wire 110-volt circuit. The 14-light outlets on the first floor are supplied each by a single circuit, as the underwriters allow this arrangement for chandeliers, and I have assumed that Mr. Cummings intends chandeliers to be used at these outlets.

H. G. Osborne.

Brooklyn, N. Y.

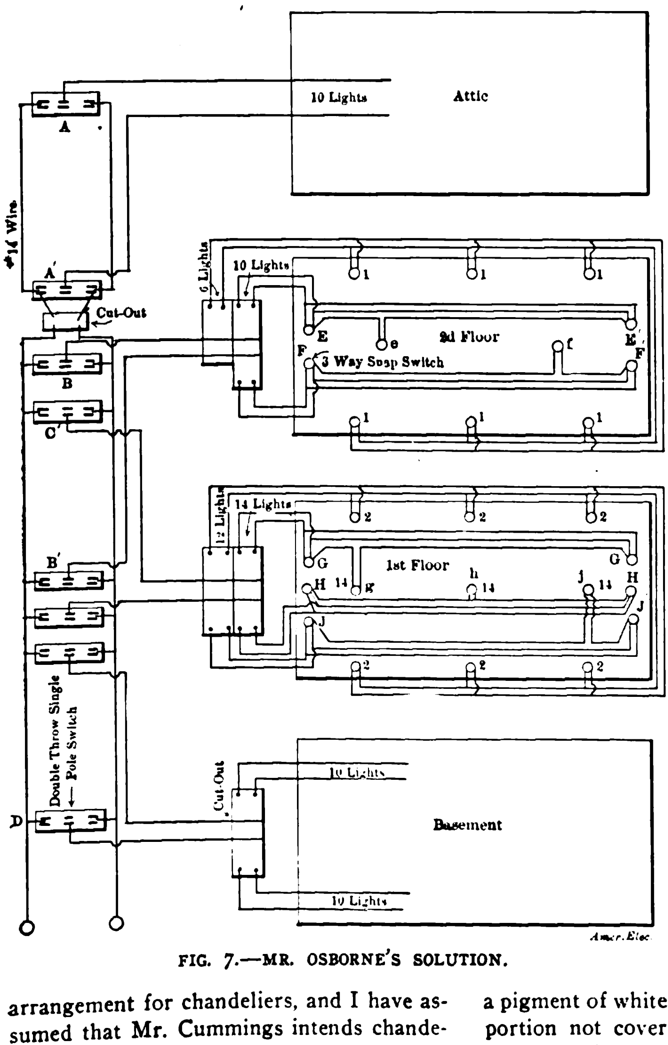


FIG. 7.—MR. OSBORNE'S SOLUTION.

[Fig. 8 is the diagram supplied by Mr. Cummings as his solution of his problem. Heretofore we have made comment on the different solutions offered to the various problems which have appeared from time to time, but we think it will probably add to the general interest if editorial comment be withheld and the readers themselves be given an opportunity to comment on the several solutions. We shall be glad, therefore, to have any reader who has been interested in Mr. Cummings' problem to offer comments on the solutions shown here, including the one submitted by the author himself. All such comments must be *received* not later than September 20, as the discussion will not be carried over to the November issue.—Editor.]

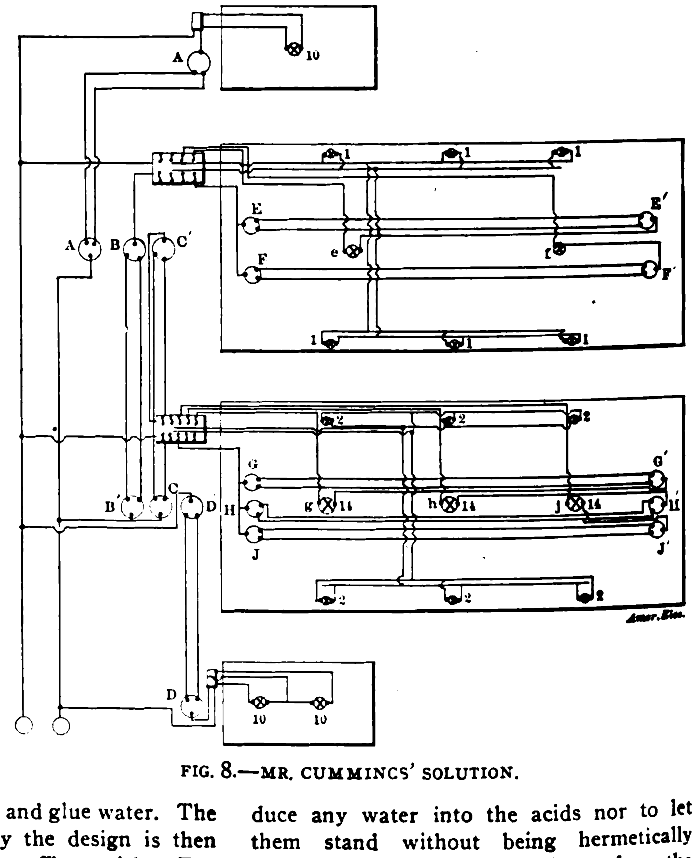


FIG. 8.—MR. CUMMINGS' SOLUTION.

Electrical Catechism

704 *How may articles be incrusted with silver, gold, or other metals?*

By incrustation is understood the inlaying of depressions, produced by engraving or etching upon a metallic body, with silver or gold and other metals, such as Japanese incrustations, which are made by mechanically pressing the silver or gold into the depressions. Such incrustations, however, can be produced by electrodeposition, the process being as follows: The design to be incrusted upon the metal is executed with a pigment of white lead and glue water. The portion not covered by the design is then covered with "stopping-off" varnish. The article is next placed in a dilute solution of nitric acid, whereby the pigment is first dissolved and next the surface etched, and this is allowed to progress to a certain depth. Etching being finished, the article is washed in an abundance of water and immediately brought into a silver or gold bath, in which, by the action of the current the exposed places are filled up with metal. This being done, the "stopping-off" varnish is removed with benzine, the surface ground smooth and polished. In this manner one article may be incrusted with several metals. For instance, brass may be incrusted with silver, copper, and gold, and, by oxidizing or coloring portions of the copper, beautiful effects can be produced. The principal requisites for these incrustations are manual skill and much patience. Expensive apparatus is not required, any skilled electroplater being able to execute the work.

705 *How may silver be stripped from plated articles?*

When a silvering operation has failed, or the silver is to be stripped from old silvered articles, different methods have to be used according to the nature of the basis-metal. Silvered iron articles are treated as the anode in a potassium cyanide solution in water (1 to 20), the iron not being attacked by potassium cyanide. As cathode a few silver anodes or a sheet of copper rubbed with an oily rag is suspended in the solution. The silver precipitates upon the copper sheet, but does not adhere to it. Articles, the basis of which is copper, are best stripped by immersion in a mixture of equal parts of fuming sulphuric acid and nitric acid. This mixture makes the copper passive, while the silver is dissolved. Care must however be taken not to introduce any water into the acids nor to let them stand without being hermetically closed, since by absorbing moisture from the air they become dilute and may then exert a dissolving effect upon the copper.

Queries and Answers

IMPORTANT. — No attention will be given to inquiries which do not give the full name and address of the inquirer.

How can I make a solution to write on glass?
L. E. R.

Mix one or two quarts of silicate of soda with eleven parts of liquid ink. Use a steel pen and wipe it after using.

Please explain the working principle of the steam injector.
E. K. E.

Such an explanation would occupy too much space for this department. You will find a complete explanation in the article on "Injectors for Boiler Feeding" which appeared in the January, 1901, issue of this paper.

How can the capacity of common fuse wire be calculated? (2) Which is preferable for use in an ordinary cut-out block, fuse wire from a spool or fuse links?
S. S.

It is not practicable to calculate the capacity of ordinary fuse wire unless you know what the character of the alloy is, and know the constants applying to this alloy, which can only be determined by experiment. (2) Fuse links.

Can a damaged armature coil on a multipolar motor having a two-path armature winding be cut out of circuit, and the commutator segments to which it was connected bridged by a "jumper," as is done in the case of an ordinary lap-wound machine?
F. M. M.

Yes; but if the damaged coil is short-circuited within itself it is likely to give trouble by heating up and damaging neighboring coils.

Since rewinding the field coils of a compound-wound direct-current dynamo the machine does not keep its voltage up under load. Before the coils were rewound the voltage varied only one or two volts from no load to full load, but since it was repaired the e.m.f. drops 14 volts when the load is thrown on; what is the trouble?
H. B.

The series winding is evidently connected up backwards, so that it demagnetizes the field instead of assisting the shunt winding and increasing the field strength.

How can I change a small 10-volt direct-current motor so that it will run on a 110-volt circuit, either alternating or direct-current?
G. B.

The machine cannot be made to operate satisfactorily on any alternating-current circuit. You can operate it on a 110-volt direct-current circuit by putting a group of 100-volt lamps in series with it, the lamps themselves being arranged in parallel. The result will not be satisfactory, however, unless the load is constant.

Please give a table of safe carrying capacities for magnet wires from No. 12 to No. 32 B. & S. gauge.
N. J.

The carrying capacity of magnet wires depends entirely upon the manner in which the wire is used, so that no single table would be of any value. The heating of a magnet coil depends upon several other factors besides the size of the wire. Refer to the articles on magnet windings in the April and May issues of 1901.

How can I start a two-phase induction motor of the usual type and operate it on a single-phase circuit?
G. L. C.

Connect one phase of the stator winding directly to the supply circuit and the other phase to the circuit through either an inductance coil or a condenser, for starting up; after speed is attained, disconnect the phase having the inductance or condenser in its circuit. See Mr. McAllister's article in the last issue of this paper.

Why are large alternators made with revolving field magnets instead of revolving armatures?
W. E H.

For several reasons; principally because the armature winding can be more effectually insulated by reason of greater available space, and the insulation can be more reliably maintained, by reason of the absence of motion. Another advantage is that there are no brushes and collector rings at dangerous potentials. A third advantage is that the field magnet, being heavier than a revolving armature would be, gives a greater fly-wheel effect.

How can I tell whether an arc lamp is connected in circuit so that the current will pass through it in the right direction?
J. A. M.

If the lamp is operating on an alternating-current circuit, it makes no difference which way it is connected in. If it is a direct-current lamp, you cannot tell beforehand whether it is connected up properly or not unless the terminals of the lamp are marked and you know the polarity of your circuit. The easiest way is to let the lamp burn for an hour or two and then inspect the carbons; the end of the upper carbon should be hollowed out and the end of the lower carbon should be tapered almost to a point. If the reverse is true, the lamp is connected in wrong.

Would it be advisable to run three three-phase feeders a distance of 100 ft. in a single conduit box? (2) Is it not necessary to twist the three wires of a three-phase circuit together when they are run in iron pipe, in order to prevent self-induction? (3) Can all the positive wires of several direct-current circuits be run in one insulated conduit box and all of the negative wires in another?
L. G. H.

There is no objection, if the wires are properly arranged to avoid mutual induction, and the insulation is adequate. (2) It is not absolutely necessary, but this is the easiest method of arranging the wires so as to avoid mutual induction. They could be bunched together in a straight line and tied at short intervals, but this would be obviously more troublesome than to twist the wires together. (3) Yes; assuming adequate insulation, of course.

A 220-volt shunt-wound motor runs without sparking with the brushes in any one of several positions, the only difference being a variation in speed; which is the best point for the brushes? (2) In what cases should single cotton-covered wire be used on motors and dynamos, and when should double cotton-covered wire be used? (3) Is fibre a good insulator for armature slots?
G. E. M.

So long as the motor runs as described there is no choice as to the position of the brushes. You will find, however, that upon putting more and more load on the motor the number of sparkless brush positions will be reduced. (2) Double cotton-covered wire should be invariably used for armature windings and for all magnet coils subjected to 500 volts e. m. f. or more. Single cotton-covered wire may be used for magnet coils on potentials less than 500 volts. (3) No. If the coils are form-wound and separately insulated you can use shellacked fuller board for the armature troughs; if the coils are wound directly into the slots, the troughs should be of micanite.

A telephone line 35 miles long gives good service so far as talking is concerned, and one of the magnetos rings through without trobule, but the other will not ring properly. The defective machine is slightly smaller than the one which works properly. Is the trouble likely to be that the machine is too weak?
A. H. H.

This certainly seems to be the cause of the trouble. If, however, the magnets and the windings are precisely the same in both machines, then the weak machine must have a ground in its armature winding.

What is the rule for calculating the size of wire and number of turns for the armature and field in converting a 110-volt motor into a 220-volt or 500-volt shunt motor? (2) How should I calculate the size of wire and number of turns on the armature and field in converting a 220-volt series motor into a 220-volt shunt motor, or vice versa? How would you decrease the speed of a 220-volt shunt motor 25 per cent. when it is impossible to increase the number of armature turns or number of coils?
F. A. C.

A very close approximate rule for converting motors or dynamos from one voltage to another is as follows: To double the voltage, use wire three gauge numbers smaller and put on twice the number of turns per coil in the field magnet and twice the number of coils with the same number of turns per coil in the armature. (2) The conversion of a series-wound motor into a shunt-wound motor of the same voltage is a somewhat complex procedure. It is necessary first to run the machine at full load; measure the voltage at the brushes at this load, calling this voltage v; ascertain the number of turns per coil in the field winding; multiply this by the full-load current, which will give you the full exciting-force in ampere turns. The armature will then have to be rewound with a sufficient number of coils and turns per coil to make the total number of wires all around the armature equal to:

$$\frac{E \times W}{v}$$

in which E is the voltage of the circuit on which the machine is to run, W is the present number of wires all around the armature, and v is the voltage mentioned above. Then calculate the field winding to give you the ampere-turns ascertained as above when the winding is subjected to the full voltage of the circuit. (3) It is not practicable to decrease the speed of a motor 25% without changing the number of armature wires. You could obtain some reduction in speed by rewinding the field with wire one size larger than the wire now on it, making the coils the same depth in inches, but this will not give you a 25% reduction on any well-designed machine.

ELECTRICALLY OPERATED AIR COMPRESSORS.

One of the most remarkable developments in the recent history of engineering progress is the constantly increasing use of compressed air as a medium of performing numerous and various industrial operations. Pneumatic tools and other appliances for the utilization of compressed air have been introduced into one field after another, with such successful and gratifying results that the advantages of using compressed air for a wide variety of purposes are now fully recognized.

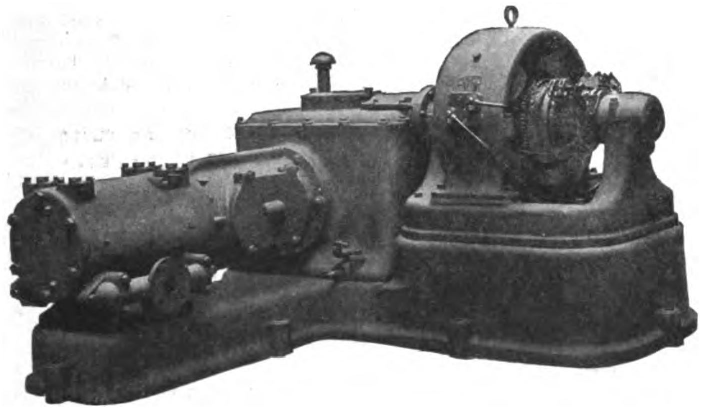


FIG. 1.—MOTOR-DRIVEN AIR COMPRESSOR.

The present general use of electricity renders it advantageous to operate air compressors with electric motors. The convenience and economy of this method is apparent when it is remembered that an electrically driven compressor can be operated from any lighting, power or railway circuit that may be available. To meet the constantly increasing demand for an electrically driven, simple, compact air compressing unit, the Christensen Engineering Company, Milwaukee, are manufacturing a complete line of motor-driven compressors ranging in capacity from 7½ to 1000 cubic feet of free air per minte. The smaller sizes are made for portable as well as stationary service.

The type "M" motor-driven air compressor illustrated by Fig. 1 herewith, is for stationary continuous service. It is built in capacities from 50 to 1000 cubic feet of free air per minute.

The electric motor and the compressor have been designed to form a compact self-contained unit. The air is compressed in the cylinder, shown on the left, by a double acting piston, which is operated by means of a connecting rod and steel crank shaft. The latter is mounted in bearings located within the frame of the machine. This shaft carries on the motor end a helical gear which is driven by a pinion on the armature shaft of the motor. The entire machine is mounted on a substantial cast-iron base. Both the cylinder and the valve heads are water jacketed throughout. The clearance spaces have been reduced to the lowest practicable limit, thereby correspondingly increasing the economy.

The suction and discharge valves are arranged in cast-iron heads bolted directly to the cylinder. They consist of seamless cold-drawn steel cups, so arranged that each is removable independent of the other. No springs are used with these valves. They are operated by the compressed air itslf, and are re-seated by gravity. The peculiar construction of these valves renders a small lift possible, hence the noise from their operation is reduced to a minimum. The suction and discharge valves are identical and interchangeable. Only one connection is necessary when piping from the compressing cylinder to the reservoir.

The piston is provided with an improved form of packing rings, which are carefully fitted in place so that they form as near a perfect sliding joint as can be obtained. The piston rod is of steel, carefully ground true on dead centers. The rod passes through a self-adjusting metallic packing box. The connecting rod is composed of steel, and is arranged to receive oil for lubricating the crank pin, wrist pin and piston. The crosshead is provided with adjustable shoes of extra large area and with an accurately ground hardened tool steel wrist pin, which fits into a phosphor bronze bearing in the rod.

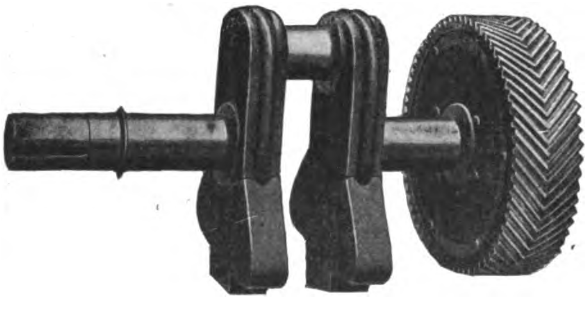


FIG. 2.—CRANK SHAFT AND GEAR.

The crank shaft shown in Fig. 2 is composed of a high-grade steel, and is provided with extra large bearings, thus avoiding the frequent adjustment of the bearing boxes, which is usually necessary with bearings of ordinary size. The shaft is carefully balanced and accurately turned true to receive the connecting rod. The crank shaft is extended at the motor end to carry the gear which is driven by a pinion on the armature shaft of the motor. The gear and pinion are of the helical herring-bone type with teeth cut by special machinery, resulting in the diminution of the noise. The gear case and the crank chamber are connected and form an enclosure which is partly filled with oil, with which all the working parts are automatically and continuously lubricated, including the air cylinder. The latter is connected with the oil chamber, so that the proper quantity of oil for lubricating the surface between the cylinder and the piston is automatically supplied and no sight feed lubricator is required. The motion of the crank shaft in the oil causes continuous lubrication of the main bearings, the crank pin bearing of the connecting rod, the crosshead guide, the piston rod, the wrist pin in the cross head and the piston. Oil is also supplied automatically to the bearings at the pinion end of the motor. The gear and pinion operate continuously in the oil bath. The machine will remain lubricated as long as the oil is kept up to a level determined by a filling plug on the side of the crank chamber. Experience has shown that after being supplied with oil, the compressor runs for several weeks before replenishing is necessary.

Either an alternating or a direct-current motor may be used. The illustrations herewith show the direct-current multipolar type that the Christensen Company built for this service. The lower frame of the motor is of cast iron, and the field is composed of low carbon cast steel with detachable steel pole pieces. The motors are series wound, and are started and stopped without using resistance of any kind. The armature is of the latest ventilated type, built up of discs of soft steel and slotted to receive the winding. Machine-formed armature coils are used; the insulation and other materials being of high grade. The commutator is built up of hard-drawn bars of lake copper insulated from each other by segments of mica. The armature shaft revolves in extra long bronze bearings with ring oiling arrangement. The bearings are so designed that it is impossible for oil to get into the armature. The brush holder is of

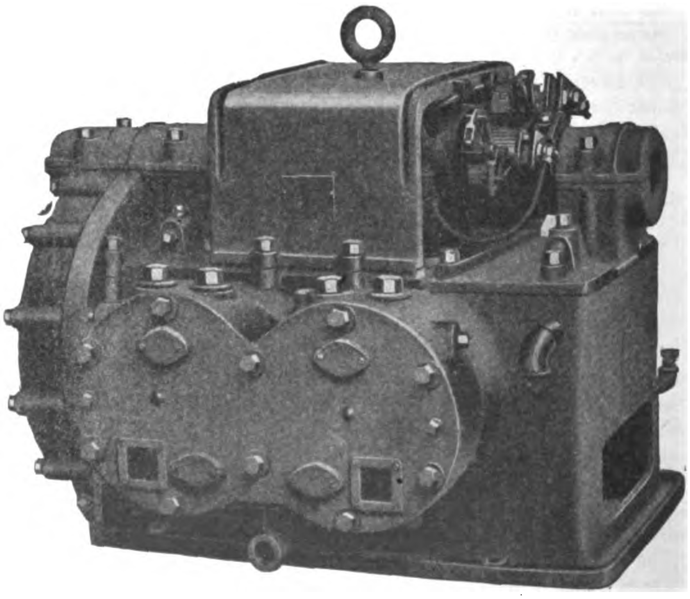


FIG. 3.—TYPE "L" COMPRESSOR.

simple construction. It is provided with an instantaneous tension adjuster arranged so that the tension can be increased while the motor is running. The design of the motor and compressor is such that every part is easily and quickly accessible. By unscrewing a few bolts the armature and the field coils can be removed or exchanged. The gear, pinion, valves or cylinder heads may also be removed without disturbing any other parts.

Access to the cross head and wrist pin is obtained by doors conveniently arranged on the side of the slide frame. The crank chamber is constructed so that it is completely closed, but the upper part may be quickly removed, giving free access to all the working parts, while a smaller hand hole covering is provided and may be easily removed for inspection of the interior.

An automatic governor starts and stops the motor compressor at the desired minimum and maximum pressures. It is a very simple piece of apparatus consisting of an ordinary pressure gauge mechanism with a special hand, which upon coming in contact with a conducting stud at the position of minimum pressure, allows current to flow through a magnet coil. This coil operates a plunger to which the contact pieces for the motor circuit are attached, thereby closing the circuit and starting the motor. As soon as the pressure reaches the desired maximum the hand strikes another stud and current passes through a second solenoid thereby pulling the plunger in the opposite direction and opening the motor circuit. By this mechanism it is possible to get a close margin between maximum and minimum pressures. This margin is readily adjusted by moving the contact studs.

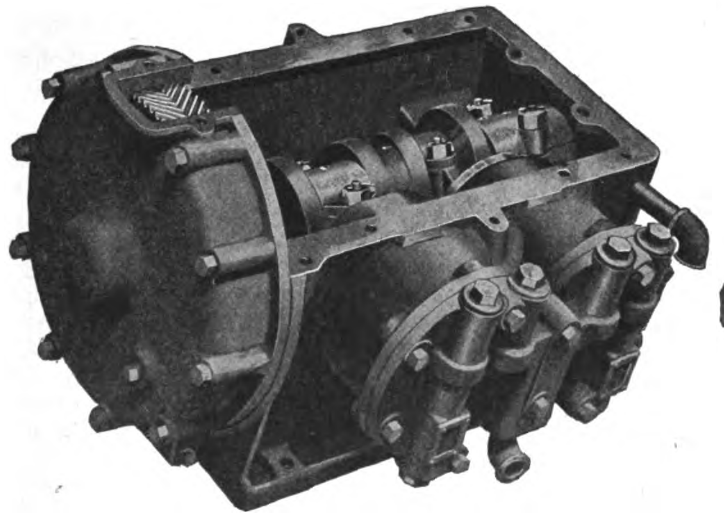


FIG. 4.—COMPRESSOR WITH MOTOR REMOVED.

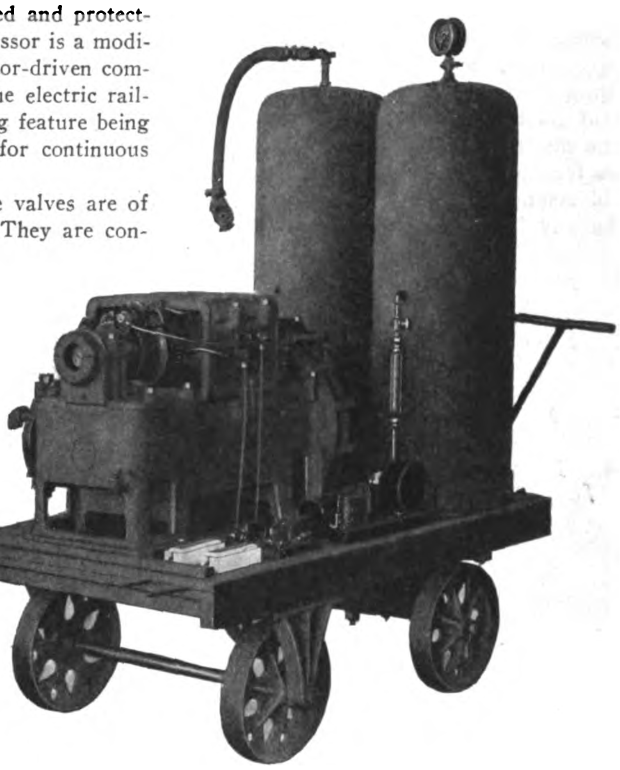


FIG. 5.—PORTABLE OUTFIT.

The governor is provided with a magnetic blow-out for extinguishing the arc and preventing the burning of the contact pieces.

All the working parts are easily accessible for inspection and the governor is protected by a cover not shown in the illustration. A smaller compressor for stationary continuous service is built in capacities from 4 to 35 cubic feet of free air per minute. This is shown by Fig. 3, and is known as type "L." The compressors are similar in design and construction to type "M," already described. The motor is mounted directly over the compressor instead of on the side. The compressor has two cylinders, which are water jacketed throughout. Each cylinder is provided with a single-acting plunger piston, which is operated by a connecting rod from a well-balanced steel crank shaft. The shaft is extended at one end to carry a helical gear, which is driven by a pinion on the armature shaft of the motor directly above. The base of the motor forms a cover for the compressor frame and the gears are also enclosed in a suitable casing. The interior of the compressor is, therefore, completely enclosed and protected from injury. This compressor is a modification of the type "H" motor-driven compressor so well known in the electric railway field, the water jacketing feature being added to make it suitable for continuous service.

The suction and discharge valves are of seamless cold-drawn steel. They are conveniently arranged in the cylinder back cover, so that each is independent of the other and separately accessible.

The illustration of the type "L" compressor shows the well-known direct current type of motor that the Christensen Company have made for several years for use with their air-brake equipments on electric cars. They are four-pole series, wound machines, with two field coils. They have cast steel frames and cast steel poles. All the other important features of the motor are similar to those used with the type "M" compressors.

For portable service the Christensen Company mount their type "H" compressor with the automatic governor and air reservoir, on a suitable hand truck which can be easily and quickly moved wherever necessary. This portable outfit, known as type "I," is shown by Fig. 5 and has a very wide field of usefulness wherever pneumatic tools or other compressed air appliances are used and an expensive system of piping is not desirable. The compressor is taken to the work instead of transmitting the compressed air from a stationary compressor at a distance.

These compressors are frequently mounted on a wagon instead of a hand truck, and transported by horses for use in drilling and bonding rails, etc., in electric railway or other work where electric power can be obtained. It is only necessary to make a connection to the trolley wire by a hook or pole for the purpose of obtaining power for the motor. Fig. 4 shows a compressor with the motor removed.

◆◆◆

TELEPHONE COUNTER.

The familiar form of cyclometer shown by Fig. 1 herewith has been adapted by the Veeder Manufacturing Company, of Hartford, Conn., to telephone exchanges where it has been used with satisfactory results. The purpose of the counter is to enable the superintendent of the telephone exchange to learn the number of calls each operator is answering per day, as well as the total number of calls answered by the exchange. A record is secured once every two weeks, or possibly one day every month. If it is found that some girls are doing considerably more work than other girls, the work is re-distributed. The two socket screws are intended to screw into the table flush, and in front but slightly to the right of the operator. The counter is attached at will by simply inserting the two pins into the twc socket screws, and it is firmly held, as can be noted by testing the appliance. The operator after inserting the plug, and when returning her hand, presses the lever, and when this is done, the instrument registers one.

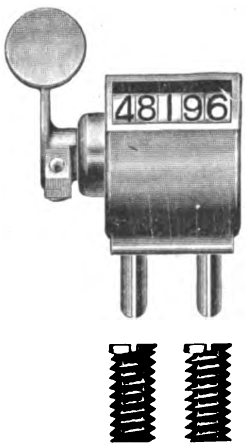


FIG. 1.—TELEPHONE COUNTER.

New Apparatus and Appliances

PARAGON MULTIPOLAR MOTORS.

It is superfluous to state that the well-known line of Paragon motors manufactured by the Paragon Fan & Motor Company, New York, has been extended to include a line of multipolar machines, ranging in capacity from 1 to 10 horsepower; but a description of some of the details of construction will undoubtedly be of interest. The armatures of these little machines are slot wound, with the now familiar barrel type of winding. The field magnet consists of a cast-iron yoke ring and laminated pole-pieces bolted to seats on the interior of the ring. The magnet poles are of the construction indicated by Fig. 2, where two kinds of stampings are shown, one having three bolt holes punched in it, and the other having a rectangular and partly closed slot in addition to the bolt holes. In assembling, a sufficient number of slotted sheets is put in near each end of the pile of laminations to take two square nuts in the recess formed by the rectangular slots, the nuts being set in place as the laminations are being assembled. When the complete pole is made up, therefore, it contains these two nuts housed in rectangular pockets, so that they cannot turn. Two heavy screws through the yoke ring engage the nuts, and combine with them to hold the magnet poles in position. The upper ends of the poles are turned to a true circular arc, and the seats in the yoke ring are turned to the same radius. The laminations are clamped together by cast-iron cheek pieces and transverse bolts, which pass through the round holes in the laminations.

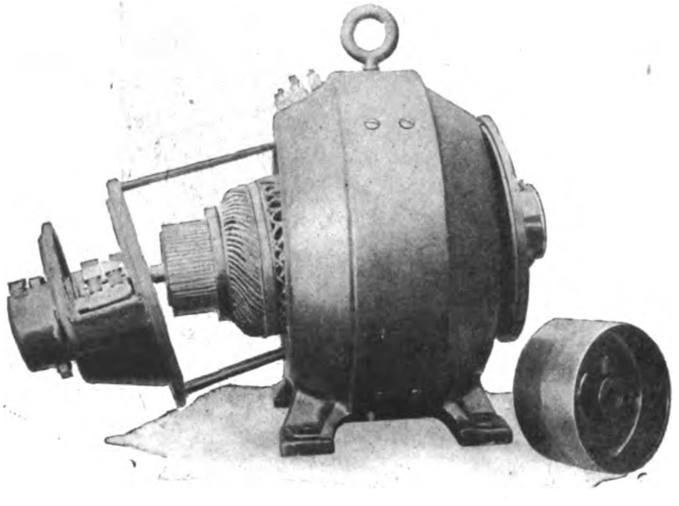


FIG. 1.—DISASSEMBLED PARAGON MOTOR.

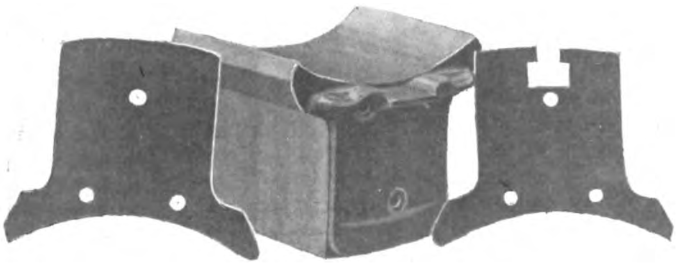


FIG. 2.—ASSEMBLED POLE PIECE AND LAMINATIONS.

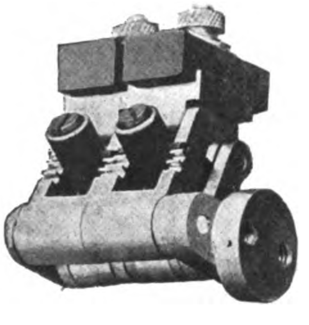


FIG. 3.—BRUSH HOLDER.

Upon close inspection, it will be noticed that one poletip of each lamination is shorter than the other, being cut off in a radial direction. In assembling the plates they are piled alternately with the long tip first in one direction then in the other, so that the complete poletips have only half the amount of metal per inch transversely that the main part of the pole contains. This method is adopted in order to saturate the poletips and promote sparkless commutation with the brushes in a fixed position.

Fig. 1 illustrates very clearly the method of assembling the machine. The end plates are turned to fit recesses in the faces of the yoke ring, and are held together by two bolts, which pass entirely through both end plates. It is only necessary, therefore, to take off two nuts in order to dismantle the machine, and the end plates can be turned through 90° or 180°, for wall or ceiling mounting. Fig. 3 illustrates the brush-holder, which is of extremely compact type, and has the advantage of maintaining the brushes at the same angle with the commutator throughout their life, and at the same time allowing them to be clamped positively to the holder, so as to avoid the resistance of a sliding contact. The parallel motion of the brush-holder is obtained by using two holder rods very close together, with two sets of links between the rods and the brush-holder. The links are so proportioned that the brushes are invariably radial as to the commutator.

ELECTRIC LOCOMOTIVES FOR INDUSTRIAL RAILWAYS.

For the transportation of material about the yards, buildings, and bays of a large manufacturing plant, the industrial or narrow-gauge railway is very convenient. If the cars and loads are small, the railway may be operated manually, but if there are grades about the plant or large quantities of heavy material to be transported, recourse must be had to some greater power. Where the plant is electrically equipped, or is lighted by electricity, the storage battery electric locomotive furnishes an ideal motive power. Fig. 4 shows such a locomotive and gives a very good idea of the form and arrangement.

The storage battery, motors, controllers and gear cases are above the platform surface which permits all the vital parts to be inspected or repaired with the utmost ease. The locomotive is carried on two swiveling trucks with every wheel a driver, giving a maximum tractive effort, and enabling it to draw large loads and ascend heavy grades. It runs smoothly around curves of 12 ft. radius so that all parts of works are accessible. The energy is furnished by a storage battery which is recharged at night or at intervals during the day when the locomotive is idle. To properly charge the battery requires about one-third the time of operation, although this depends somewhat upon the duty put upon the locomotive, but in any event the daily cost of current for charging is not very great. The battery is divided into sections through the controller with the motor armatures and fields in various series—parallel combinations. No rheostats or resistances of any kind are on the locomotive, and consequently there is no waste of energy in starting or running. Two Westinghouse vehicle type motors are mounted, one driving each truck, and these are so proportioned to the normal output of

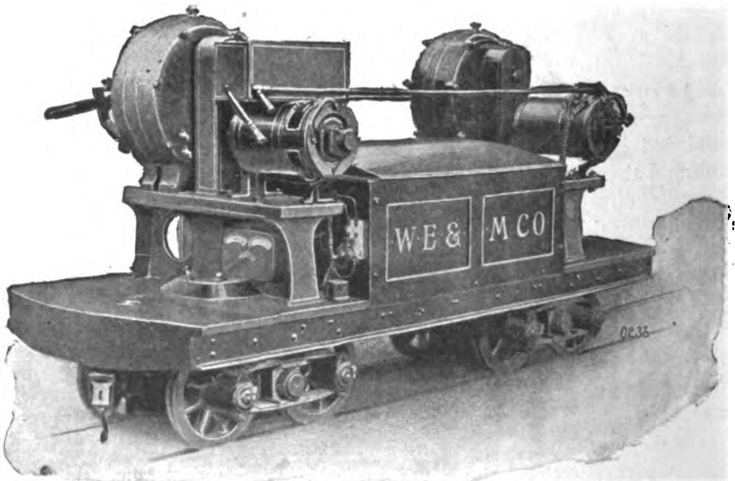


FIG. 4.—ELECTRIC LOCOMOTIVE.

the batteries and the weight of the locomotive that they cannot be overloaded by the motorman. One of these locomotives is capable of hauling about 50 tons on the level, and a corresponding load on grades. The locomotive is made by the C. W. Hunt Company, of New York.

AUTOMATIC OIL CIRCUIT-BREAKER.

Figs. 5 and 6 show two forms of the Hartman automatic oil circuit-breaker manufactured by the Hartman Circuit Breaker Company, of Mansfield, Ohio. The breaker has only lately been placed on the market and is designed for exposed locations, where it would be unsafe or impracticable to place the ordinary air-brake instrument. It is particularly adapted for street-car and for motor use. There are no exposed current-carrying parts and the operating mechanism being entirely enclosed, the instrument is not affected by exposure to damp and unfavorable locations. The special feature of this circuit-breaker is the operation of the switch mechanism in oil. The lower part of the case containing the laminated copper contacts is filled with oil of a quality which will not stiffen when subjected to low temperatures, and the break in the circuit taking place in this non-conducting fluid the formation of an injurious arc is prevented under the most severe conditions of overload or short-circuit. Where this appliance is installed no additional switch need be used, as it operates as an oil switch as well as a circuit-breaker. It can be readily thrown by pressing the rubber knob projecting from the upper part of the case and the breaking of the circuit is accomplished with absolute safety to the operator. The double-pole circuit-breaker shown in Fig. 6 cannot be closed during the continuance of an overload or short-circuit. Each side of the switch operates independent of the other and closing one switch does not complete the circuit. As soon as it is attempted to close the second switch, if a short-circuit exists, the first switch being free to act will immediately fly open. For switchboard use the circuit breaker is installed on the back of the board and when so placed only the switch-handles and the device for opening the circuit-breaker by hand appear from the front of the board.

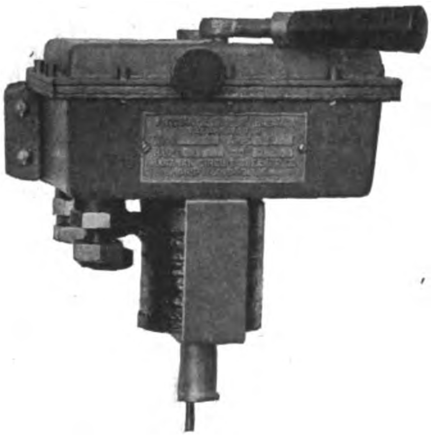


FIG. 5.—SINGLE POLE CIRCUIT-BREAKER.

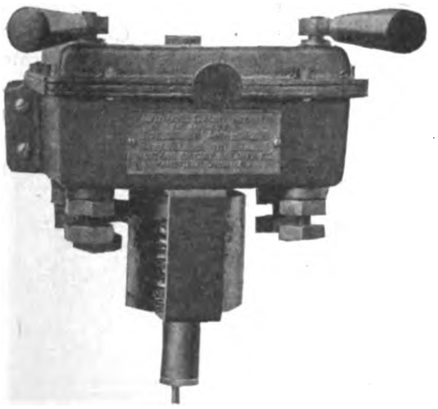


FIG. 6.—DOUBLE POLE CIRCUIT-BREAKER.

NEW WOOD DIRECT-CURRENT 110-VOLT ENCLOSED-ARC LAMP.

One of the most important features of an arc lamp for indoor use is its ability to operate on the same circut with incandescent lamps. For stores, small factories, warehouses and in many cases for street lighting, the 110-volt direct-current enclosed-arc lamp is often the logical solution of the lighting problem, and enclosed arc lamps are acknowledged to be the best source of strong diffused light so necessary in interior illumination, almost irrespective of the character of the building.

The "Wood" enclosed-arc direct-current lamp, designated as "multiple type, Form C," illustrated herewith, has been designed especially for indoor service on 110-volt mains. The foundation of the lamp is the brass carbon tube in the center. On this is mounted an iron casting in the upper part of the mechanism chamber to which is attached the top of the lamp, the terminals, the armature and the magnet. On the lower part of the tube is mounted a brass casting which forms a support for the adjusting coils and dash-pot plunger. Below this is the radiator casting from which all the lower parts of the lamp are supported.

The mechanism of the lamp is extremely simple both in design and construction. It consists essentially of an armature carrying the clutch rod and the dash pot, and an actuating magnet whose coil is in series with the arc. The armature is pivoted to a casting mounted on the central tube. The pole of the magnet is conical in shape and the armature has a circular opening which encircles the conical pole as the armature is attracted upward. Suspended from the armature is the clutch rod and the dash pot. To the lower end of the clutch rod is attached the clutch, which is located below and outside the mechanism chamber. The dash-pot plunger is supported on an extension of the brass casting on the carbon tube. Dash pot and plunger, carbon rod and clutch are all held in place by brass spring cotters. The dash pot is large and the plunger is accurately fitted.

The upper casting carrying the "steadying" resistance is mounted on the lamp top. The resistance consists of a continuous coil of high-grade resistance wire threaded through porcelain insulating tubes which are mounted on the outside of the casting and held tightly in place by tinned steel binding wire. The resistance casting has inwardly projecting vanes or ribs which conduct the heat from the coil and dissipate it by radiation. The resistance coil is protected from the weather by a short cylindrical copper case and the overlapping top. Expansion of the coils is amply provided for by proper proportions of the case and castings.

In most arc lamps no provision is made for protecting the mechanism chamber from the heat of the arc. Even when the chamber is ventilated from the bottom, as is sometimes the case, dust and other objectionable matter are drawn up through the mechanism chamber, causing deposits and oxidation which in time give serious trouble. In the "Wood" lamp the chamber is protected by a cast-iron plate which forms the top or roof of the radiator and the floor of the chamber. The radiator proper is located between the mechanism chamber and the globe holder and consists of a cast-iron "umbrella" with radial vanes on its upper surface which furnishes abundant radiating surface to get rid of the heat from the arc. The heat is deflected outward from the center and prevented from entering the mechanism chamber by the air space and separating plate above it. The lower part of the radiator serves to secure a rigid support for the outer globe holder to which it is attached by improved bayonet catches.

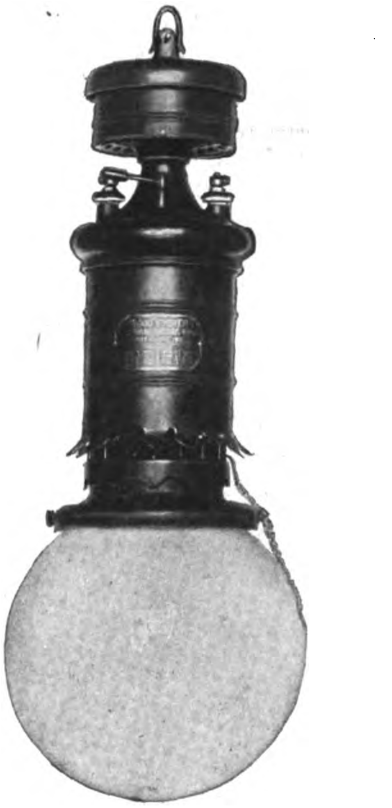


FIG. 7.—WOOD ENCLOSED ARC LAMP.

The gas cap is of cast iron and is composed of an upper dish-shaped casting and an under ring casting, separated by asbestos insulation and clamped together to form a rigid support for the lower carbon holder and inner globe. Its appearance is plainly shown in Fig. 8. The structure of the gas cap is such that no difference of potential exists on the exposed upper surface where dust is liable to collect and form a short circuit. This is an important point especially where the lamp is used with no outer globe. The lower part of the gas cap, on which the inner globe is seated, is but slightly larger in diameter than the globe and is therefore almost entirely protected by the globe against sudden changes in temperature caused by cold draughts of air. The upper part of the gas cap overhangs the lower and further protects it from chills, so that the gas cap proper always has the same temperature as the globe.

The lower part of the gas cap contains a circular interior groove or air duct between the inside and outside of the inner globe or carbon chamber. This serves as an equalizer between temperature outside and inside as the temperature inside the globe varies with the length of the arc. With an increase in temperature hot gas is driven from the globe by the expansion of the gas within and with ordinary gas caps a decrease in temperature draws in fresh cold air containing oxygen in much larger proportion than efficient operation demands. This consumes the carbon rapidly. The construction and proportions of this equalizing duct are such that no air can enter the globe without becoming heated and combined with the gas present to such an extent as to have no accelerating effect on the consumption of the carbons.

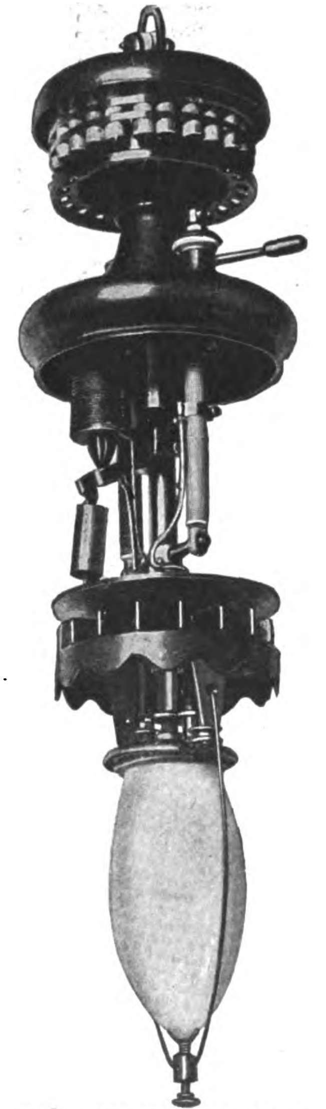


FIG. 8.—WOOD ENCLOSED ARC LAMP.

The opening in the center of the gas cap through which the upper carbon passes is lined with a removable copper bushing, this material being used to avoid rust and consequent interference with the proper operation of the feeding mechanism.

The inner globe holder consists essentially of a wire bail hanger supporting at its lowest point a casting, through which passes a short vertical post; on the top of this post is mounted a small inverted tripod in which rests the closed bottom of the inner globe. Constant pressure is maintained by the tripod against the globe by means of a small oil-tempered spiral spring on the post under the tripod. The small contact of the inner globe-holder on the globe serves, it is explained, to prevent the discoloration or breakage of the glass by overheating or unequal expansion due to uneven heating of the glass. The inner globe is removed for trimming the lamp by merely drawing down the tripod and releasing the globe. In removing the globe the spiral-spring is compressed and any dirt contained in it is ejected through the two openings in the casting below, thus preventing the clogging of the spring. No part of the inner globe holder is in circuit, so that there is no danger of receiving a shock while removing the globe.

The lower carbon holder consists of a ring casting with a copper thumb screw for securing the carbon in the holder and a set-screw for clamping the holder on the supporting rod. A small wire bail under the holder prevents the dropping of the carbon should the thumb screw loosen; in trimming, this bail is pushed aside while the carbons are being inserted. The supporting rod carrying the lower carbon holder is attached to the gas cap by a set screw and, although rigidly held in alignment, is easily detached.

The upper carbon holder is combined with a trolley which collects current from the carbon tube. It consists of two semi-cylindrical phosphor bronze jaws attached to the lower end of the trolley and having annular contact on the carbon instead of a cylindrical contact. By this means the carbon is kept in good contact with the holder and in free alignment even though the carbon may be crooked or irregular in shape. The lower end of the trolley body projects downward between the two jaws and serves as a stop for the upper carbon to limit its entrance into the holder to the proper amount. The upper carbon holder and the trolley combined are several times heavier than a single carbon, so that the percentage of change in the weight supported by the carbon clutch and armature as the carbon is consumed is comparatively small, and consequently the adjustment of the lamp will not be affected practically by the reduction of the weight of the carbon.

The lamp operates with 80 volts at the arc and is normally adjusted for 5 amperes, but it can be adjusted to operate satisfactorily with any current from 4½ to 6 amperes. The maximum range of voltage at the arc under normal operating conditions is 10 volts, the lamp striking an arc cold at 75 volts and operating continuously with 80 to 85 volts at the arc hot. The normal life of one set of high-grade cored upper and solid lower carbons is 150 hours when the lamp is adjusted for a current of 5 amperes. Like all Wood apparatus, the lamp is built by the Fort Wayne Electric Works.

TELEPHONE SNIP.

Fig. 9 shows a telephone or electrical snip manufactured by the Smith & Hemenway Company, of New York. The instrument is of service to linemen, electricians, bell-hangers or anyone who in any way strings wires. It is of heavy make and has a powerful leverage for cutting and stripping. It is made of nickel-plated high-grade material and is warranted by the manufacturers.

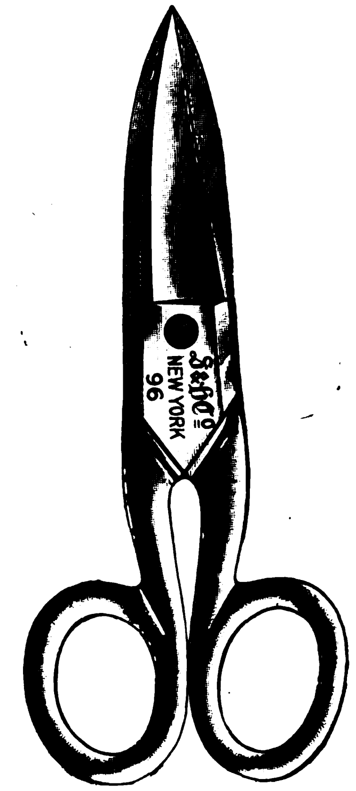


FIG. 9.—TELEPHONE SNIP.

CONVENIENT DESK PAD.

The accompanying illustration shows a desk pad recently invented by the Meyercord-Batterman Company, of Chicago. The material used in the pad is of a patented composition which makes the pad flexible as well as waterproof. All ink stains, dust and dirt can be readily removed by the application of a damp cloth. The surface is finished in any shade of wood to match any shade of desk, and combines an interest computing table, postal rate table, an 18-in.

THE EVER CLEAN DESK PAD

FIG. 10.—CONVENIENT DESK PAD.

measure, and the metric system reduced to inches. The back of the pad is finished in canton flannel, so as not to scratch the desk. The pad obviates the necessity of the old-style blotting pad, and even though previously rolled up will lie perfectly flat.

COMMUTATOR CONNECTIONS.

In the article on "Points in Rewinding Coil-Wound Armatures," which appeared in the July number, the figures in the 8-pole column of the table of commutator connections for multipath wave windings were wrong. In copying from original data the figures in this column were inadvertently made the same as the corresponding figures in the 4-pole column. The table is, therefore, reprinted herewith, with the correct figures in the 8-pole column, in order that those who are interested in the subject may cut out this copy of the table and substitute it for the original table.

TABLE III.—COMMUTATOR BARS BETWEEN THE TWO TO WHICH ANY ONE ARMATURE COIL IS CONNECTED IN A MULTIPATH WAVE WINDING.

No. of Coils	4 Poles	6 Poles	8 Poles	No. of Coils	4 Poles	6 Poles	8 Poles
24	10-12	6	....	147	....	49	....
27	....	7-9	....	148	72-74	....	....
28	12-14	....	....	150	....	48	....
30	....	10	....	152	74-76	....	36-38
32	14-16	....	6-8	153	....	49-51	....
33	....	9	....	156	76-78	52	....
36	16-18	10-12	....	159	....	51	....
39	....	13	....	160	78-80	....	38-40
40	18-20	....	8-10	162	....	52-54	....
42	....	12	....	164	80-82	....	....
44	20-22	....	....	165	....	55	....
45	....	13-15	....	168	82-84	54	40-42
48	22-24	16	10-12	171	....	55-57	....
51	....	15	....	172	84-86	....	....
52	24-26	....	....	174	....	58	....
54	....	16-18	....	176	86-88	....	42-44
56	26-28	....	12-14	177	....	57	....
57	....	19	....	180	88-90	58-60	....
60	28-30	18	....	183	....	61	....
63	....	19-21	....	184	90-92	....	44-46
64	30-32	....	14-16	186	....	60	....
66	....	22	....	188	92-94	....	....
68	32-34	....	....	189	....	61-63	....
69	....	21	....	192	94-96	64	46-48
72	34-36	22-24	16-18	195	....	63	....
75	....	25	....	196	96-98	....	....
76	36-38	....	....	198	....	64-66	....
78	....	24	....	200	98-100	....	48-50
80	38-40	....	18-20	201	....	67	....
81	....	25-27	....	204	100-102	66	....
84	40-42	28	....	207	....	67-69	....
87	....	27	....	208	102-104	....	50-52
88	42-44	....	20-22	210	....	70	....
90	....	28-30	....	212	104-106	....	....
92	44-46	....	....	213	....	69	....
93	....	31	....	216	106-108	70-72	52-54
96	46-48	30	22-24	219	....	73	....
99	....	31-33	....	220	108-110	....	....
100	48-50	....	....	222	....	72	....
102	....	34	....	224	110-112	....	54-56
104	50-52	....	24-26	225	....	73-75	....
105	....	33	....	228	112-114	76	....
108	52-54	34-36	....	231	....	75	....
111	....	37	....	232	114-116	....	56-58
112	54-56	....	26-28	234	....	76-78	....
114	....	36	....	236	116-118	....	....
116	56-58	....	....	237	....	79	....
117	....	37-39	....	240	118-120	78	58-60
120	58-60	40	28-30	243	....	79-81	....
123	....	39	....	244	120-122	....	....
124	60-62	....	....	246	....	82	....
126	....	40-42	....	248	122-124	....	60-62
128	62-64	....	30-32	249	....	81	....
129	....	43	....	252	124-126	82-84	....
132	64-66	42	....	255	....	85	....
135	....	43-45	....	256	126-128	....	62-64
136	66-68	....	32-34	258	....	84	....
138	....	46	....	260	128-130	....	....
140	68-70	....	....	261	....	85-87	....
141	....	45	....	264	130-132	88	64-66
144	70-72	46-48	34-36	267	....	87	....

NEW BOOKS.

Generators of Electricity at the Paris Exhibition of 1900. By C. F. Guilbert. Paris: C. Naud. Paper: 766 pages, 7 ins. x 10½ ins.; 615 illustrations; 10 tables. Price, 30 francs.

This is an excellent collection of data relative to all generators of more than 30 kilowatts output that were exhibited at the Paris Exposition two years ago, and constitutes, therefore, a fair presentation of modern European practice in this branch of engineering. Alternators, direct-current dynamos and rotary converters are included in the scope of the book. These machines are described in a general way and the constructional features illustrated in the body of the book, while the chief engineering data of the various designs are tabulated at the end. The illustrations include elevations and plans of the machines and such details as armature-core slots, armature spiders, field-magnet-pole construction, etc.; and the characteristic curves of many of the machines are given. The book is in French, but the tables of data are in French, English and German. The only real causes for adverse comment are the absence of dimension marks on some of the reproduced drawings and the incompleteness of magnetic data in the omission of densities and the total magnetic flux per pole. All of the essential dimensional figures for most of the machines, however, are given in the tables, and in the large majority of cases sufficient data are given to enable one to compute magnetic densities and other omitted figures.

OBITUARY.

W. A. SCOTT, president of the Illinois Wire Company, died in Chicago on August 9. Mr. Scott was for a number of years president of the Marshfield & Southeastern Railroad Company, and owner of the Scott Lumber Company. He was 43 years old at the time of his death, and leaves a widow and one son.

GEORGE M. HOPKINS, for many years associate editor of the *Scientific American*, died after a very short illness on August 17 at Cheshire, Mass., whither he had gone for a vacation. Mr. Hopkins was taken suddenly ill on August 15 while enjoying a trolley outing with his wife among the Berkshire Hills, and in spite of the very best medical attendance died two days later. Mr. Hopkins was born in Oakfield, N. Y., November 21, 1842, and although his formal training was only that of the usual public school course, he acquired a wide knowledge of mechanical and electrical science. He was a prolific inventor for a period of about twenty years, beginning in 1866. In 1876 he became connected with the *Scientific American* as an attorney in the patent department of that paper, and soon thereafter became associate editor of the paper, which position he held up to the time of his death. A wife, one son and a brother survive him.

PERSONAL.

MR. H. B. THAYER, vice-president of the Western Electric Company, has returned from a two months' rest in Europe.

MESSRS. KEMPSTER B. MILLER and W. W. DEAN, of the engineering staff of the Kellogg Switchboard & Supply Company, are enjoying a hunting trip in Colorado.

MR. C. O. BAKER, of Baker & Co., the well-known platinum refiners, has been elected a member of the board of directors of the National State Bank, of Newark, N. J.

MR. GEO. W. SCOTT, the well-known consulting engineer of Chicago, has been given charge of extensive improvements and additions to the electrical and steam power plant of Parke, Davis & Co., Detroit, Mich.

MR. WM. E. DICKEY, previously general manager of the Clonbrock Steam Boiler Company, is now New York representative of the Goulds Manufacturing Company of Seneca Falls, N. Y., and the West Point Boiler Works (R. Munroe & Sons) of Pittsburg, Pa. Mr. Dickey's headquarters are at 16 Murray Street.

MR. W. F. D. CRANE, who has been associated for some time past with the firm of Sanderson & Porter, has severed his connection with that firm and accepted the management of the contract department of the American Stoker Company, New York. Mr. Crane's headquarters will be at the New York office of the company.

MR. A. L. HAVENS, who for several years past has been the city salesman in Chicago for the Western Electric Company, resigned this position recently to accept the management of the sales department of the Kilbourne & Clarke Company, Seattle, Wash. Mr. Havens will also represent the Western Electric Company and the Warren Electric Manufacturing Company in Seattle.

MR. D. S. HULFISH, formerly switchboard engineer of the Central Union Telephone Company, has accepted the position of electrical engineer of the Baird Manufacturing Company, Chicago.

MR. W. J. JONES, formerly on the staff of the Gas & Electric Company of Bergen County, N. J., has been appointed manager of the Stanley Electric Manufacturing Company's branch office at Denver, Colo.

MR. KARL G. ROEBLING, of the well-known Roebling Company, is busy receiving congratulations on the announcement of his engagement to Miss Blanche Estabrook, a daughter of H. T. Estabrook, the general solicitor of the Western Union Telegraph Company.

MR. CHAS. F. SCOTT, president of the American Institute of Electrical Engineers, and chief electrician of the Westinghouse Electric & Manufacturing Company, has returned from England, where he has been engaged for several months on important engineering work.

MR. HORACE PORTER has resigned the position of assistant superintedent of the Cincinnati Traction Company to accept the superintendency of the street railway property at Paducah in Kentucky. The company owning this system has been reorganized and the system will be greatly improved and extended.

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TRADE PUBLICATIONS.

BLOWERS. American Blower Company, Detroit, Mich.—Catalogue No. 141, containing illustrations, descriptions, and the usual data relating to "A B C" pressure and volume blowers.

DIRECT-CURRENT SERIES ENCLOSED ARC LAMPS. Fort Wayne Electric Works.—This is bulletin No. 1026, containing a copiously illustrated description of the Wood differential arc lamp built for direct-current series circuits.

THE PURIFICATION OF WATER BOILERS. D. W. & R. P. Patterson, Philadelphia, Pa.—A well-executed series of bulletins removably bound together, and containing illustrations and descriptions of the Bachman system of water purification.

LIGHTNING ARRESTERS.—General Electric Company.—Publication No. 1040, containing an interesting article on the subject of Atmospheric Electricity and Lightning Protection, By Prof. Elihu Thomson, together with illustrated descriptions of the various lightning arresters and appurtenances built by the General Electric Company.

STATIC GROUND DETECTORS. Wagner Electric Manufacturing Company, St. Louis, Mo.—Bulletin No. 52, containing an illustrated description of the round-pattern type of static ground detector manufactured by the Wagner Company. The instrument is of the familiar electrostatic vane class, and is made for circuits of from 1100 to 11,000 volts.

BRASS GOODS AND STEAM SPECIALTIES. The Lunkenheimer Company, Cincinnati, Ohio.—This is a very complete catalogue of reduced size, containing illustrations and data relating to the well-known Lunkenheimer regrinding globe and angle valves, radiator valves, check valves, gate valves, safety valves, steam whistles, lubricators, oil cups, automatic oilers, etc.

FEMCO INCANDESCENT LAMPS. The Franklin Electric Manufacturing Company, Hartford, Conn.—This is the 1902 catalogue of the Franklin Company, and contains illustrations and descriptions of the various incandescent lamps manufactured by this company. The line includes the usual standard lamps and also special lamps of the round bulb, tubular and other forms.

DIRECT-CURRENT MOTORS. Northern Electrical Manufacturing Company, Madison, Wis.—Bulletin No. 29, containing an illustrated and detailed description of the multipolar motors built by this company. These excellent machines are built in sizes ranging from 1/8-horse-power up, and are adapted to innumerable classes of service, many of which adaptations are illustrated by finely-executed engravings in this bulletin.

INNER GLOBES FOR ENCLOSED ARC LAMPS. The Phœnix Glass Company, New York and Pittsburg.—This is a very complete and compact catalogue, containing outline-dimensioned illustrations of the line of inner globes manufactured by this company. This line includes all of the standard globes used by the General Electric, Westinghouse, General Incandescent Arc Light, Western Electric, Jandus, Adams-Bagnall, Fort Wayne, and other companies manufacturing arc lamps.

METROPOLITAN INJECTORS. The Hayden & Derby Manufacturing Company, New York.—This is the 1902 catalogue of this company, which contains, in addition to the usual illustrations and descriptions of the Metropolitan injectors, some valuable suggestions as to the selection of an injector and the adaptation of this class of boiler feeder to the conditions under which it is to work. The catalogue also contains information concerning ejectors, strainers, check valves, and other specialties built by the Hayden & Derby Company.

STROWGER AUTOMATIC TELEPHONE SYSTEM. Automatic Electric Company, Chicago.—This is the first catalogue of the Automatic Electric Company, which, on January 1 of this year, purchased the business of the plant of the Strowger Automatic Telephone Exchange Company. The catalogue is handsomely executed and contains concise statements of the advantages of the Strowger automatic system, as well as illustrated descriptions of the various types of telephone sets, keyboards, automatic switches, etc., which go to make up the system.

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BUSINESS NEWS.

JAS. McCREA & CO., Chicago, announce that the Baltimore & Western Supply Company, St. Paul, Minn., has been appointed agent for the sale of their well-known steam specialties.

TUCKER ELECTRICAL CONSTRUCTION COMPANY, New York, report that they were the general contractors for the residential installation on Fisher's Island, N. Y., which was described in the August number of this paper.

DIELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., was recently incorporated with a capital stock of $3,000, and has succeeded the Western Dielectric Company in the manufacture and testing of insulating materials.

IMPERIAL ELECTRIC COMPANY, Philadelphia, Pa., has removed its offices from 16 N. 7th Street to No. 28 N. 7th Street, where the company has leased an entire building and will have much greater facilities for its growing business in incandescent lamps and other specialties.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has removed its district office from the Sun Building, Washington, D. C., to the Continental Trust Building, Baltimore, Md., this move being made necessary by reason of the large amount of business transacted in Baltimore.

MICA INSULATOR COMPANY, New York, is extending its manufacturing plant so as to increase its capacity by about 50 per cent. When this increase in facilities is completed the company will be in position to fill with the greatest promptness all orders for its well-known specialties in micanite and other insulating goods.

AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., announces that after September 30 no more free scholarships will be awarded. It behooves those who are interested in this subject, therefore, to "make hay while the sun shines," and take advantage of the remaining thirty days during which free scholarships may be obtained.

COMMUTATOR COMPOUND COMPANY, Battle Creek, Mich., is receiving a great many cordial testimonials to the merits of its "Nevergum," a new commutator compound manufactured by this company. Nevergum is put up in sticks 7/8 in. in diameter and 4 ins. long; it flows readily at a temperature of about 105 degrees Fahrenheit, and is claimed not to gum the commutator or brushes under any conditions of service.

WESTINGHOUSE, CHURCH, KERR & CO. have removed their New York office from the Havemeyer Building, 26 Cortlandt Street, to the Maritime Building, 8 and 10 Bridge Street, opposite the new Custom House, near Bowling Green, at the lower end of Broadway. This change has been made because of the urgent necessity for larger quarters. The new quarters contain about twice the floor space that was available in the old offices on Cortlandt Street.

THE ALBERGER CONDENSER COMPANY, New York, recently closed a large contract with the Commonwealth Electric Company of Chicago for a complete condensing plant to be installed in that company's new power house. This plant will include one of the largest surface condensers ever furnished for use on land. It is of the Alberger high vacuum type, and will have 20,000 square feet of cooling surface. The pumping plant used in connection with this condenser consists of an Alberger dry vacuum pump with Corliss valves; a centrifugal circulating pump; a hot well with a

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pump driven by a Corliss engine; a heater of 2,000 square feet surface and two vertical boiler-feed pumps. The entire equipment represents the most advanced form of condensing engineering. This condensing plant will operate in connection with a 7500-h.p. steam turbine, and a vacuum of 28 inches is required to be maintained.

THE SUNBEAM INCANDESCENT LAMP COMPANY, of Chicago, reports an unusually good business for the summer months, and has secured several substantial contracts for export which were the results of rigid competitive tests.

THE ALADDIN ELECTRIC COMPANY, Ravenna, Ohio, has been organized for the purpose of engaging in the business of refilling burned-out incandescent lamps. The company announces its determination to supply the best refilled lamp that it is possible to produce and to overcome whatever prejudice may exist against this class of lamps.

KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, recently closed a contract for a common-battery multiple-switchboard telephone system for Vincennes, Ind., the ultimate capacity to be 1,500 lines, with a framework large enough to permit of expansion to 3,000 lines. The contract includes also 600 standard common-battery wall telephone sets and all the necessary power apparatus, distributing frames, etc., for the exchange.

CROCKER-WHEELER COMPANY, Ampere, N. J., has been forced by the large increase in its business to extend its factory facilities. A new three-story building is now in process of construction and this will be devoted to the winding departments and light machine tools. All of the smaller machines now in the main shop will be transferred to the new building, so as to permit the installation of new machinery of the heavier type in the main shop.

THE PAYNE ENGINEERING COMPANY has removed its New York office from 120 Liberty St. to 141 Broadway. The company announces that M. A. Hudson and H. S. Whitney, formerly with Manning, Maxwell & Moore, have been appointed associate managers of the New York office, and C. Lawrence, formerly with the New York & New Jersey Telephone Company, has been appointed resident engineer.

THE PEERLESS ELECTRIC COMPANY. Warren, Ohio, which, as noted elsewhere in this column, has taken over the transformer and fan motor business of the Warren Electric & Specialty Company, will add to its list of fan motors a line of alternating-current machines, which will be ready for next season's trade. The company has also arranged to produce an excellent line of small power motors.

INSTRUCTION CARDS.—The instruction cards prepared by H. K. McCay, of the McCay Engineering Company, Baltimore, Md., for the use of engineers, dynamo tenders, and other practical workers, have met with a warm welcome; which is but natural, as these cards contain information bearing directly on the operation and handling of generators, motors, and other apparatus, as well as some convenient formulas for calculating wire sizes.

PITTSBURG GAGE & SUPPLY COMPANY, Pittsburg, Pa., have secured the contract for three 250-h.p water-tube boilers for the new plant of the Susquehanna Iron & Steel Company at Columbia, Pa., and two 125-h.p. boilers for the Cadiz (Ohio) Electric Light & Power Company. The company has also closed contracts with the National Steel Company for a complete White Star filtering system, and with the electric department of the Carnegie Steel Company and the Wheeling Steel & Iron Company for White Star filtering systems.

FOSTER ENGINEERING COMPANY, Newark, N. J., calls attention to the fact that the annual report of Admiral Melville, of the United States Navy, shows that this company furnished to the United States government during the year 1901 automatic reducing and regulating valves aggregating 17,683 lbs. in weight. The company reports a large trade in its well-known Class W, back-pressure, automatic safety stop, non-return and other valves. Among recent purchasers of these valves are the Consolidated Car Heating Company, Colorado Fuel & Iron Company, The Heine Safety Boiler Works, Cleveland Electric Illuminating Company, and the New York Edison Company.

THE NERNST LAMP COMPANY has brought out a special lamp designed particularly for the illumination of telephone switchboards. This lamp has already been adopted in several stations and is reported to give a much more satisfactory illumination on the switchboard than the usual incandescent lamp, and at the same time to offer complete protection to the eyes of the attendant. One Nernst lamp does the duty formerly requiring three incandescents. The Nernst lamp is found to be particularly well adapted for the illumination of boards using the lamp signal system on account of the soft white light emitted, enabling the operator to readily distinguish the switchboard lamps when lighted.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., is introducing the Jackson portable electric hammer, which is said to be the only electric hammer on the market. It is stated that this hammer can be used to advantage wherever chipping of any kind, riveting, calking or stone-dressing and carving is required, and is adapted for all classes of work now done by pneumatic hammers, such as chipping iron or steel in foundry work, bridge building, boiler work, structural iron work, ship building, etc. The hammer can be operated by a motor of from 1/8 to 1/4 horse-power, supplied from any ordinary constant-potential circuit.

THE ELECTRIC STORAGE BATTERY COMPANY reports among recent contracts for chloride accumulators to be used in railway service the following: A 350-kw. outfit for the Mahoning Valley Railway Company, Youngstown, Ohio; a 264-kw. outfit for the Harrisburg (Pa.) Traction Company; a 259-kw. outfit for the Eastern Ohio Traction Company; a 1700-kw. outfit, divided into two batteries, for the Milwaukee Electric Railway & Lighting Company; a 600-kw. outfit for the Ottawa (Ont.) Electric Railway Company, and a 210-kw. outfit for the Orange & Passaic (N. J.) Railroad Company. Other contracts for smaller outfits too numerous to mention have also been Closed.

ROBERT A. KEASBY, of New York, desires to call the attention of the trade to "magnesialith," which is an improved composition for floor covering that is said to be absolutely fire-proof, springy to the tread, and does not become slippery like concrete. This flooring is adapted to service in power houses as a substitute for the top dressing

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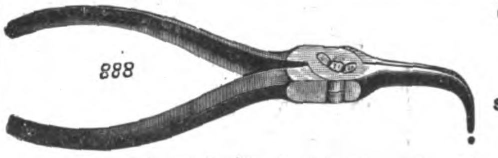

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SARGENT, CONANT & CO., of Boston, have been awarded the contract for the entire mechanical and electrical equipment of a new textile plant which will be built at Philadelphia by the Crompton & Knowles Loom Works of Worcester, Mass. Power for the entire works will be transmitted and distributed electrically.

THE ALLIS-CHALMERS COMPANY has received an order from the Southern Electric Light Company, Philadelphia, for a Reynolds combined vertical and horizontal engine having a minimum capacity of 8,000 and a maximum of 12,000 horsepower. The engine will be almost exactly like the eight engines now in the power station of the Manhattan Elevated Railway, this city, and the eight engines to be installed by the subway company.

AUTOMATIC ELECTRIC COMPANY, Chicago, manufacturer of automatic telephone apparatus, has closed contracts for independent exchanges in the cities of Columbus and Dayton, Ohio. The Columbus exchange will have an initial capacity of 6,000 subscribers, and the Dayton exchange will have an initial equipment of 7,000 lines; both exchanges are to have an ultimate capacity of 19,000 subscribers each.

THE LAKE SHORE LIMITED STILL RUNS.—The report that was circulated some time ago to the effect that the Lake Shore Limited train between New York and Chicago had been withdrawn when the Twentieth Century Limited of the New York Central & Hudson River Railroad Company was put into service, has been emphatically contradicted by Mr. Geo. H. Daniels, general passenger agent of the company. The Lake Shore Limited continues to leave New York at 5:30 p. m. every day, arriving in Chicago the following afternoon at 4:30 o'clock.

THE KENTUCKY ELECTRICAL COMPANY, Owensboro, Ky., is moving into its new factory, a two-story brick building, the erection of which was made necessary by the rapid increase in business last year. The lamp department is equipped with modern appliances and has an immediate daily capacity of 3,500 incandescent lamps, with ample room to increase this output to 5,000 per day. In the dynamo and motor department, all machine tools will be electrically driven and with facilities for building up to 50 kilowatts.. The present line will be increased immediately to 30 kilowatts.

THE NEW PROCESS RAW HIDE COMPANY, Syracuse, N. Y., announces that an arrangement has been made with Geo. Angus & Co., Ltd., Newcastle-on-Tyne, England, whereby the latter company is to establish a plant in England for the manufacture of raw hide gears and other specialties under the patents and secret processes of the American company, using the latter company's trade mark. The new plant, it is expected, will be able to take care of all of the New Process Raw Hide Company's present business in Great Britain and throughout Europe, as Angus & Co. have offices in nearly all of the principal cities of Europe.

THE REPLOGLE GOVERNOR WORKS, of Akron, Ohio, expect to ship shortly, through the Pelton Water-wheel Company, New York, five sectroidal relay water-wheel governors and three duplex relay governors to Spain. These were contracted for in competition with Swiss and German manufacturers. One of the Replogle latest differential relay governors has just been shipped to the Rochester (N.Y.) Gas & Electric Company, and a relay returning governor has been sent to the Montreal Cotton Company, Valleyfield, Que. Electrical relay governors will shortly be shipped to the Shattuck & Babcock division, American Writing Paper Company, DePere, and to Eben Stevens, Quinebaug, Conn.

WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, announces that its fan motor and transformer business has been sold to the Peerless Electric Company of that city, and that it will hereafter manufacture incandescent lamps exclusively. During the past two months the Warren Company has made large additions to its lamp works and refitted the works thoroughly with the most complete and modern manufacturing equipment obtainable. New factory buildings have also been erected and equipped, and its corps of expert workers has been greatly increased. The company will hereafter push the manufacture of miniature and decorative lamps in addition to its regular trade in standard goods.

THE TRIUMPH ELECTRIC COMPANY, Ohio, reports that its business for the summer months has been astonishingly large. Among recent sales were a 200-kw. direct-connected generator, with 56 motors aggregating 520 horse-power, for the Krell French Piano Company, Newcastle, Ind.; two 100-kw. and one 50-kw. direct-connected machines for the Wooster University; two 200-kw. generators and 27 motors aggregating 910 horse-power, for the Globe-Wernicke Company; two 100-kw. direct-connected generators for the water works and electric light plant at Norwood, Ohio, and two 125-kw. belted generators for the Kanawha Valley Traction Company, Charleston, W. Va. There were also a great many sales of smaller machines, an enumeration of which is impracticable by reason of space limitations.

AMERICAN UNION ELECTRIC COMPANY, New York, announces that in addition to its purchase of the Union Railway Power & Electric Company, Morris Electric Company, The Falcon Electric Manufacturing Company, Electric Motor Specialty Company, Fountain Manufacturing Company, The Federal Manufacturing & Specialty Company, and Refrigerator Machine Company, it has purchased all of the capital stock of the Metropolitan Switchboard Company, which company enjoyed a large trade in the well-known Murphy switchboards and panel boards. The factory of the Metropolitan Company in New York City will be continued in operation, and all switchboard and panel board work will be turned out under the supervision of T. J. Murphy, formerly president of the company which has been absorbed, and patentee of many special forms of panel boards and panel board boxes.

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Vol. XIV. New York, October, 1902. No. 10.

A REBUILT AND ENLARGED CENTRAL STATION.

THE RIVER STATION OF THE UNITED ELECTRIC COMPANY OF NEW JERSEY AT NEWARK.

The United Electric Company of New Jersey was organized in April, 1899, with an authorized capitalization of $20,000,000, for the purpose of furnishing current for light, power and other purposes over an extensive territory of a population of almost 1,000,000, which is constantly increasing. The company absorbed the Peoples Light & Power Company, which operated the electric plants at Newark, Orange and Jersey City, and also the North Hudson Light, Heat & Power Company of Hoboken, the Consumers' Light, Heat & Power Company of Elizabeth, and the Morris County Electric Company of Morristown and Boonton. Of these the growth of the Peoples Light & Power Company was remarkable for the reason that new property and customers were acquired from time to time by entering the field of supply on a competitive basis, furnishing current at a lower rate and then purchasing the opposition company and equipping their station with improved apparatus. Not only did they by this method prevent other companies from furnishing current, but their vigilance and low rates also induced every municipality wanting current to purchase it from them. Owing to this sagacious business management, at the time of the consolidation very few isolated plants were to be found in the territory covered by the company.

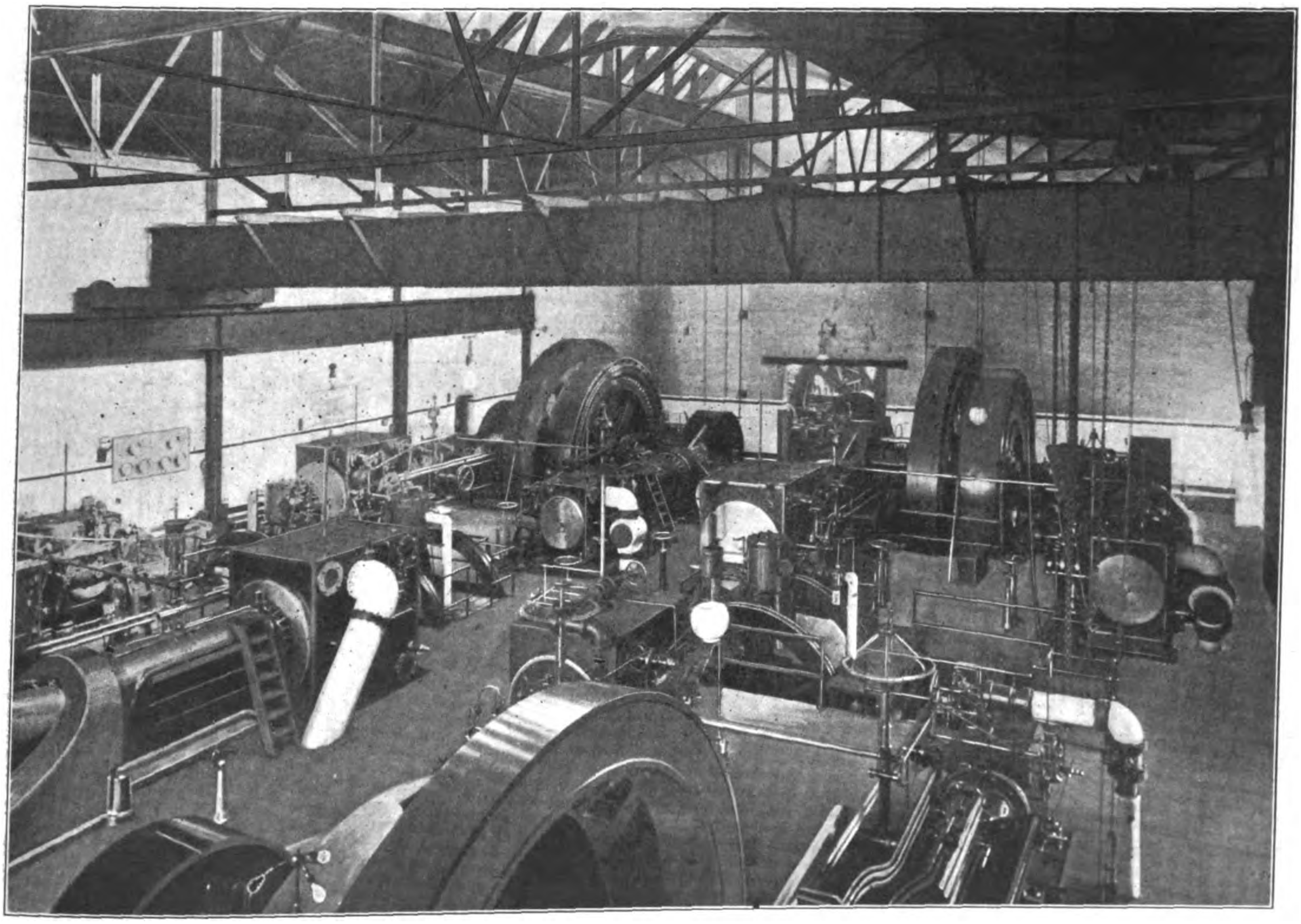


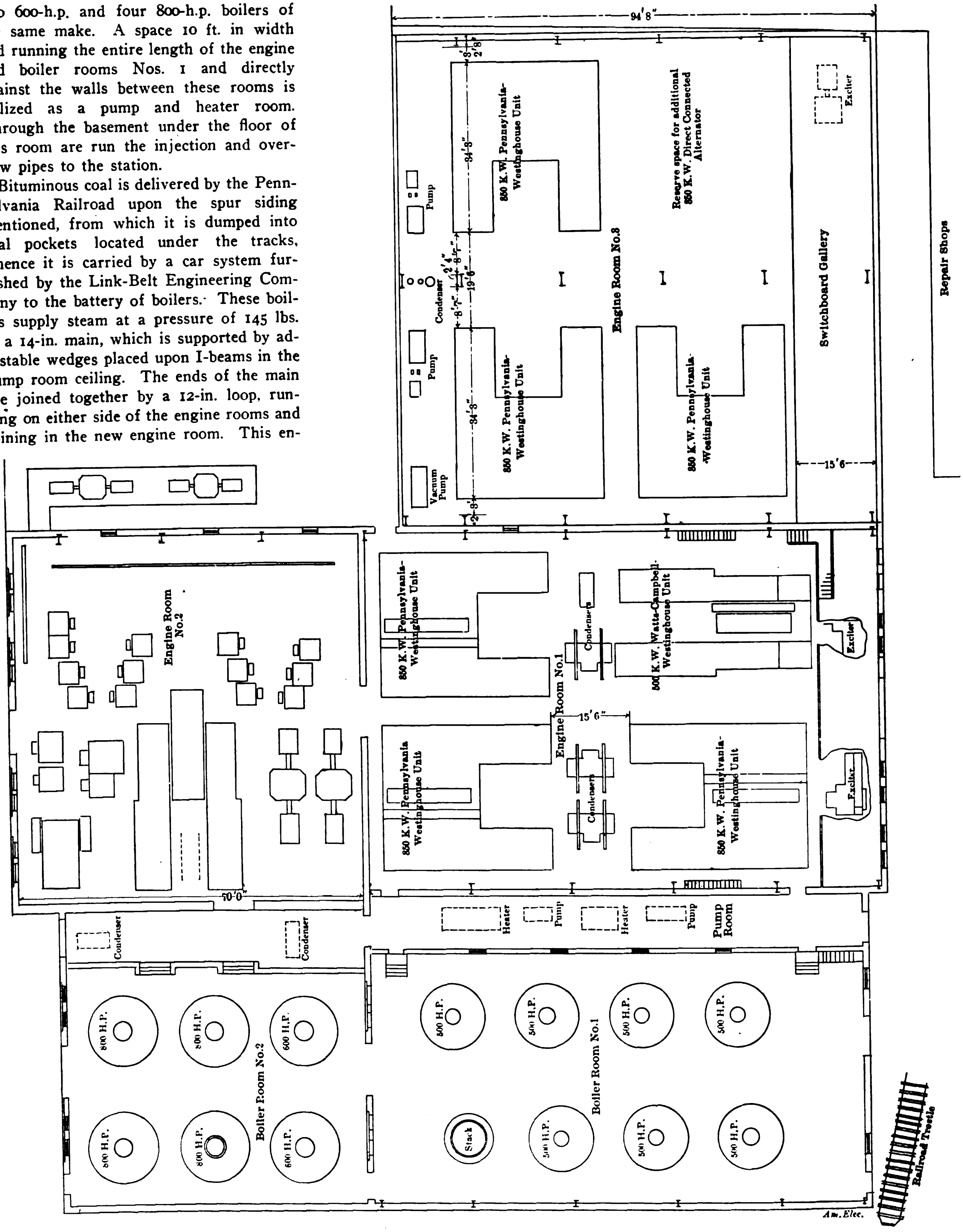
FIG. I.—GENERAL VIEW OF ONE OF THE ENGINE ROOMS IN THE RIVER STATION AT NEWARK, N. J.

The plant at Newark was destroyed by fire about five years ago, and its reconstruction resulted in a marked change in the apparatus and system used by the company. The plant was also greatly enlarged, so that at the present time its capacity is double what it was before the fire.

The construction of the new river station was begun in the fall of 1897, and since that time a new engine room has been added. The station is admirably situated upon the west bank of the Passaic River to the right side of the Pennsylvania Railroad entering Newark, and is located between the main line and the Center Street branch of that road. A spur is run to the west side of the power house from the railroad track, over which all the coal for the station is carried. Fig. 2 is a plan view showing the general lay-out of the station. The building is divided longitudinally into three sections, one part being occupied by the two boiler rooms, which are again divided by a brick wall, the second part constituting engine rooms 1 and 2, also divided by a brick wall, and the third part constituting the new engine room. The switchboard gallery extends across the entire west end of the latter room. In boiler room No. 1 are seven 500-h.p. Morrin Climax boilers, and in boiler room No. 2 are two 600-h.p. and four 800-h.p. boilers of the same make. A space 10 ft. in width and running the entire length of the engine and boiler rooms Nos. 1 and directly against the walls between these rooms is utilized as a pump and heater room. Through the basement under the floor of this room are run the injection and overflow pipes to the station.

Bituminous coal is delivered by the Pennsylvania Railroad upon the spur siding mentioned, from which it is dumped into coal pockets located under the tracks, whence it is carried by a car system furnished by the Link-Belt Engineering Company to the battery of boilers. These boilers supply steam at a pressure of 145 lbs. to a 14-in. main, which is supported by adjustable wedges placed upon I-beams in the pump room ceiling. The ends of the main are joined together by a 12-in. loop, running on either side of the engine rooms and joining in the new engine room. This enables each engine to be run from either end of the main, which is sub-divided by valves in such a manner that any section may be cut off without affecting the rest of the main.

The piping system was installed by Westinghouse, Church, Kerr & Co. of New York. All fittings are extra-heavy and the piping is covered with the Nonpareil Cork Manufacturing Company's covering. The piping is dripped into a Holly system, which returns the condensation to the boilers. Fig. 5 is a view of a portion of this piping system in the basement of the new engine room. In the center of the illustration may be seen the receiver of the Holly system which takes care of the high-pressure drips, returning them to the boilers. Fig. 3 shows diagrammatically the steam, exhaust, injection, overflow and feed piping of two of the Pennsylvania engines in engine room No. 1. All of the piping and apparatus is clearly marked in the engraving, so that any further explanation is unnecessary. A feature of the piping is



94'8"
850 K.W. Pennsylvania-Westinghouse Unit
Reserve space for additional 850 K.W. Direct Connected Alternator
Exciter
Pump
34'8"
2'8"
19'6"
Condenser
Engine Room No.3
Switchboard Gallery
Repair Shops
Vacuum Pump
15'6"
Engine Room No.2
Engine Room No.1
850 K.W. Pennsylvania-Westinghouse Unit
500 K.W. Watts-Campbell-Westinghouse Unit
Condensers
Exciter
70'0"
Condenser
Heater
Pump
Pump Room
800 H.P.
600 H.P.
500 H.P.
Boiler Room No.2
Boiler Room No.1
Stack
Railroad Trestle
Am. Elec.

FIG. 2.—PLAN VIEW OF THE RIVER STATION AT NEWARK, N. J.

the smallness in size of the pipe used. Ordinarily, one would expect to find in a plant having a capacity of about 9000 horse-power 24-in. or 30-in. mains, but the largest main in the plant is 14-in. and the engines are fed from a 12-in. line. In order that the drop in steam pressure should not be excessive and to insure the delivery of sufficient steam to the engines, a receiver of from three to five times the size of the high-pressure cylinder is placed near the throttle of each engine. In the operation of this plant on this piping system the maximum drop between the pressure in the boiler and the throttle of the engine has never exceeded 3½ lbs. Another peculiarity of the system is the method of providing for expansion. Bends are not used, but a sort of swinging joint somewhat similar to a two-armed gas bracket is employed. This joint is shown diagrammatically by Fig. 4. It is made up of elbows and screwed nipples, being dripped from one end of the tee where the steam enters. The joint is obviously very flexible and it would appear that some difficulty would be experienced in keeping the joint steam tight, but such a difficulty has not arisen, the joint operating very satisfactorily.

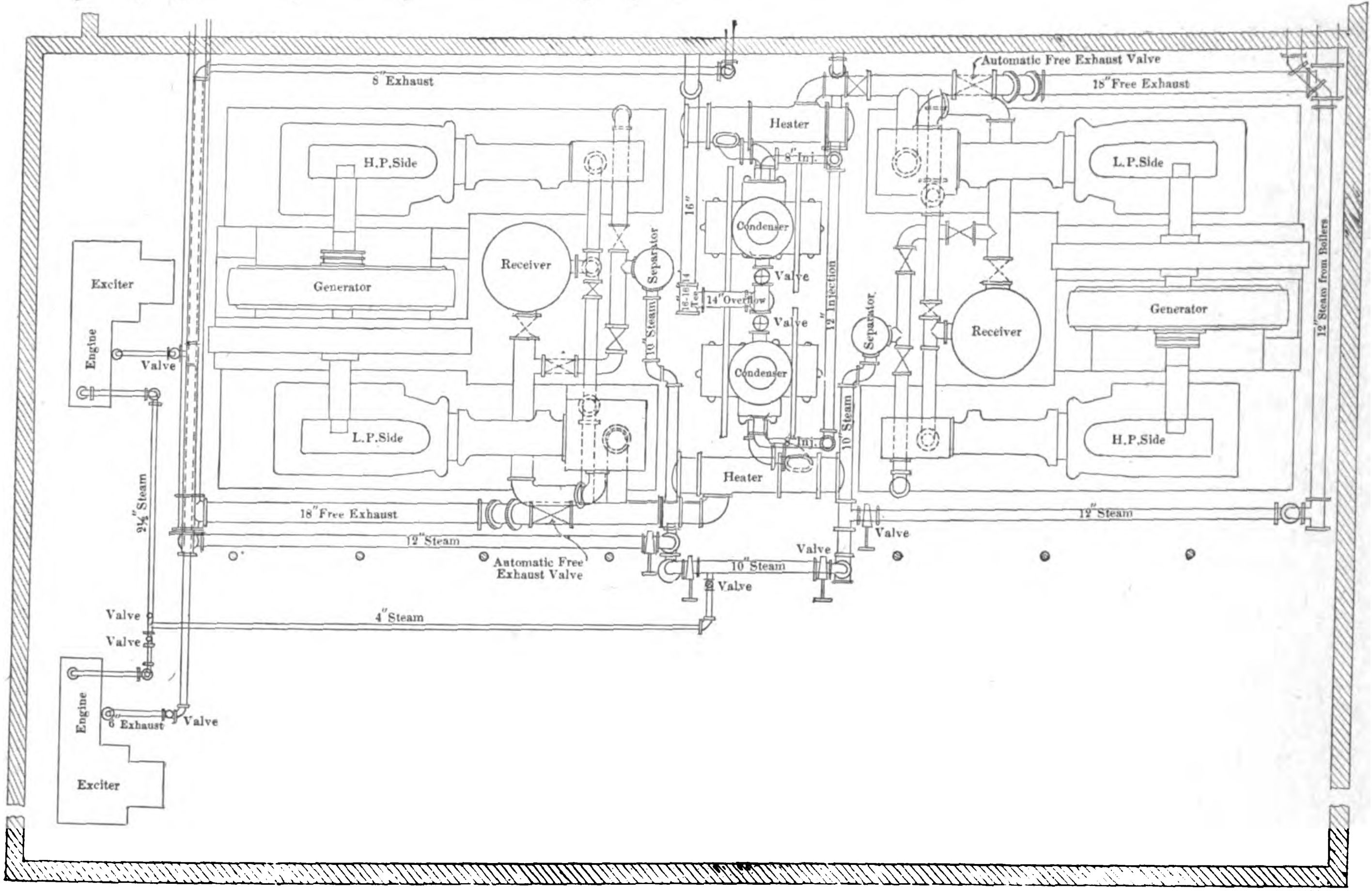

8" Exhaust
Automatic Free Exhaust Valve
18" Free Exhaust
Heater
8" Inj.
H.P. Side
L.P. Side
Condenser
Valve
14" Overflow
16"
10" Steam
Separator
Receiver
Generator
Exciter
Engine
Valve
12" Injection
12" Steam from Boilers
Heater
18" Free Exhaust
12" Steam
Automatic Free Exhaust Valve
10" Steam
2¼" Steam
4" Steam
6" Exhaust
Am. Elec.

FIG. 3.—PLAN OF PIPING IN ENGINE ROOM NO. 1.

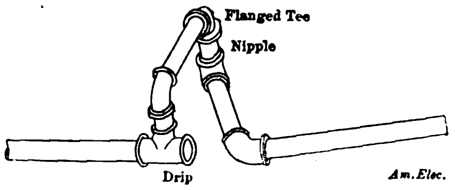

Flanged Tee
Nipple
Drip
Am. Elec.

FIG. 4.—EXPANSION JOINT.

The equipment in engine room No. 1 consists of three Pennsylvania Iron Works Company's 30 x 52 x 48 cross-compound condensing engines, each direct-connected with Westinghouse 850-kw. two-phase alternating-current generators delivering 2300 volts at a frequency of 60 cycles. The generators are of the rotary field type and supply the current for the incandescent lighting, having a capacity of 50,000 lights. Two 62-kw. Westinghouse generators direct-connected to 8 x 14½ x 10½ tandem-compound McIntosh & Seymour engines running at 175 r.p.m. act as exciters. There is also one 20 x 40 x 48 Watts-Campbell cross-compound engine direct-connected to a 500 kw. 500-volt Westinghouse direct-current generator, which is used to supply the current for the power circuits. This engine exhausts into a Worthington horizontal jet condenser. The exhaust from the Pennsylvania engines is conducted through feed-water heaters to the specially designed jet

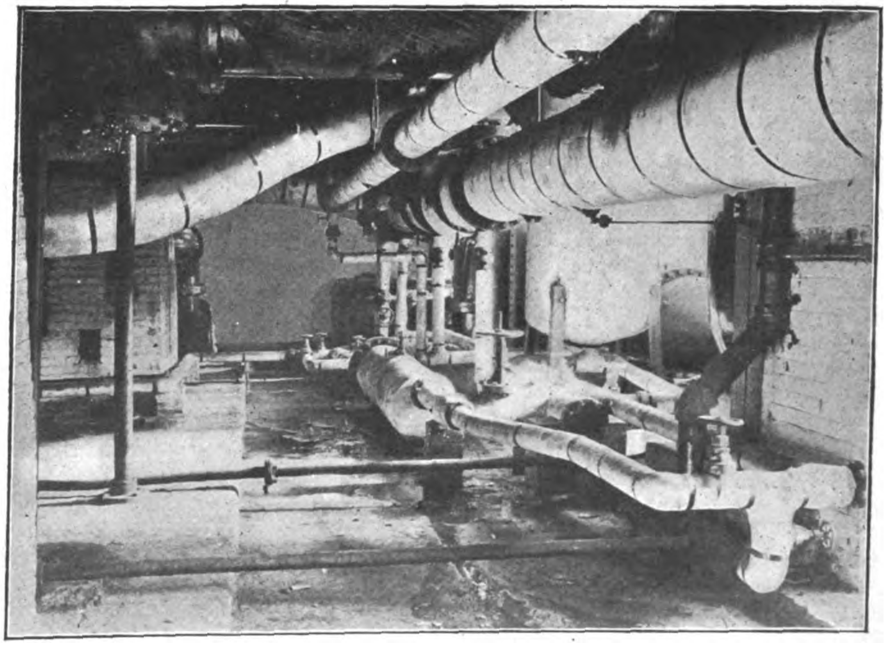


FIG. 5.—PIPING IN BASEMENT OF NEW ENGINE ROOM.

condensers of the engine type made by the Pennsylvania Iron Works Company. Fig. 1 is a general view of this engine room. Two 12-in. cast-iron flanged injection pipes run from the river through the pump room cellar and supply water to the various condensers. A 20-in. cast-iron bell and spigot pipe carries the overflow water from the condensers to the river.

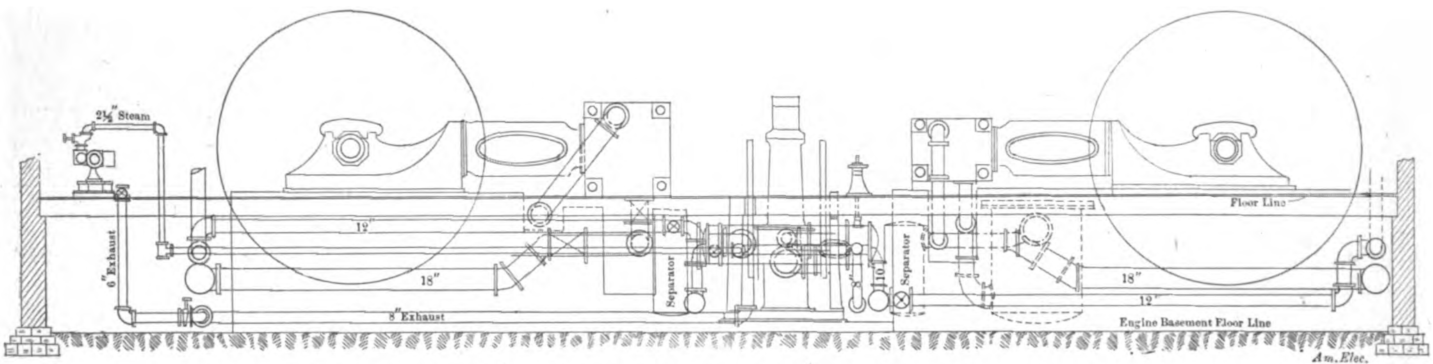


FIG. 6.—ELEVATION OF PIPING IN ENGINE ROOM NO. 1.

In engine room No. 2, which is devoted entirely to arc lighting, are twenty-two 60-kw. arc-light machines generating current at 6250 volts. Eight of these are driven by Westinghouse induction motors, each motor driving two arc machines through a flexible coupling. Thirteen of the others are belted to a shaft which is driven by a 26 x 48 x 50 Watts-Campbell cross-compound condensing engine. There is also located in this room an 18½ x 31 x 16 Armington & Sims cross-compound condensing engine, which drives a Western Electric arc machine, a 250-kw. 550-volt direct-current Westinghouse generator, and two 75-kw. direct-current Westinghouse generators of 220 and 125 volts, respectively. The Armington & Sims engine exhausts into a Wheeler horizontal surface condenser and the Watts-Campbell engine exhausts into a Worthington horizontal jet condenser. All of the conductors in engine room No. 2 are lead covered and run in conduits made by the National Conduit and Cable Company; these are situated under the floor.

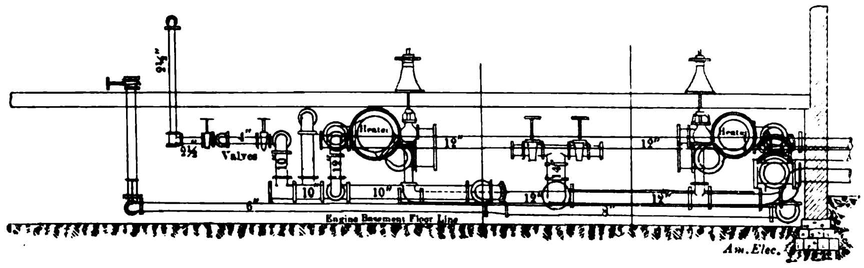


FIG. 7.—END VIEW OF PIPING IN ENGINE ROOM NO. 1.

Engine room No. 3 was designed for four main generating units, two of which are in operation and the third in process of erection. Space is provided for the fourth unit, as shown in the plan view of the station. Each of the main units comprises a Pennsylvania cross-compound engine of the Corliss type direct-connected to a 2300-volt Westinghouse alternating-current generator. These machines have a nominal rating of 850 kilowatts at an exceptionally low temperature. They are guaranteed to carry 1050 kilowatts continuously at 2300 volts, with a rise in temperature of 40 degrees. They have a maximum capacity of 2650 volts at 185 amperes per phase. The inherent regulation of the machines is 10 per cent. The generators are designed and guaranteed to generate their normal load of 850 kilowatts with an efficiency of at least 95 per cent., and to take a 60 per cent. overload with an efficiency which will not fall appreciably below that point. At 50 per cent. of their normal load of 850 kilowatts the efficiency is guaranteed to be at least 92 per cent. The rheostats for the field coils are capable of reducing the voltage of the machine when running at its normal speed to one-half of its normal voltage. Fig. 10 is a view showing the two units now in operation in this engine room.

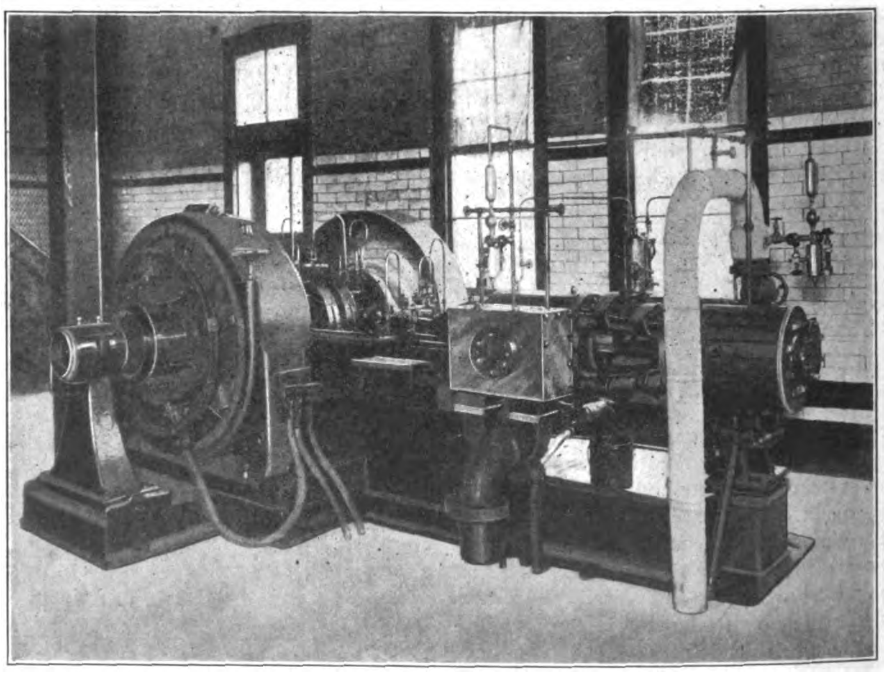


FIG. 8.—ENGINE-DRIVEN EXCITER UNIT.

The Pennsylvania engines are designed for a speed of 90 revolutions per minute, at which speed they are capable of developing continuously, without passing their limit of cut-off, 2300 horse-power when running non-condensing. The cylinders are attached to heavy frames proportioned to work with an initial pressure in the high-pressure cylinder of 145 lbs. per square inch. The low-pressure cylinders are designed to withstand and work with an initial pressure of 95 lbs. per square inch. The cylinders are so proportioned as to safely withstand the steam pressures mentioned after having been rebored twice. The clearance in the high-pressure cylinder is about three per cent., and about two per cent. in the low-pressure cylinder. The cylinders are made of hard close-grained iron and the exhaust chambers are cast separately from them, in order to reduce the internal condensation. The back cylinder heads are covered with false covers and both heads are steam jacketed. Besides this the cylinders are lagged with magnesia plastic covering, and each end of each cylinder is fitted with a snifting or relief valve in order to prevent accidents in case water accumulates in the cylinders. The engines are so designed and piped that either side can be satisfactorily operated independently by disconnecting the connecting rod on the other side, and under these conditions each cylinder is capable of developing 1600 horse-power.

The valves are of the double-ported Corliss type, which permit the engines to be operated under any condition of load with or without condensers. The high and low-pressure valve-gears are provided with separate eccentrics for the exhaust and admission valves. Both the valve-gears are so designed that the cut-off can take place as far as the three-quarters stroke. Both valve-gears are controlled by one regulator, the low-pressure gear being arranged so as to be easily disconnected from the regulator when the engine is running and operated at very low cut-off. The wrist-plates on each side are provided with a coupling arrangement so that the two plates can be coupled together to permit of working the admission and exhaust valves together. They are also provided with a steam-actuating mechanism having a floating lever similar to a marine reversing gear, so that the valves can be moved to and fro by the steam gear in a manner corresponding to the motion of the hand lever of the reversing gear. The coupling device has a locking mechanism, making it impossible to couple the two plates to their eccentric rods when they are connected together or to the steam-gear.

Between the high and the low-pressure cylinders there is placed in a vertical position under the floor a reheater receiver designed to withstand a working pressure of 145 lbs. and provided with traps to drain it of the water collected by condensation. The heater has a capacity four times that of the low-pressure cylinder and has 1200 sq. ft. of super heating surface provided in the form of a coil.

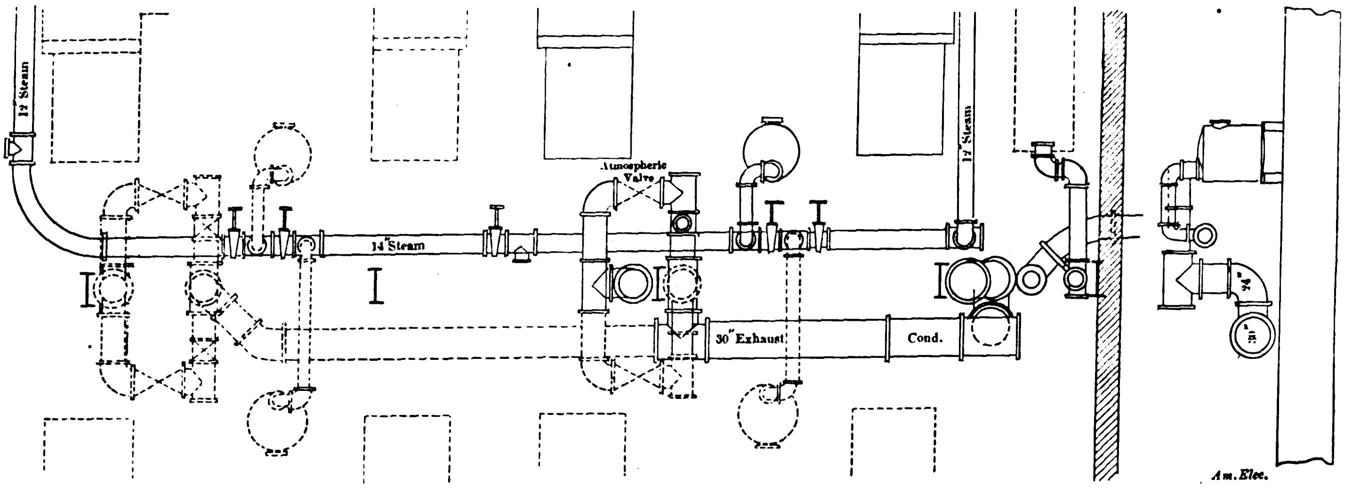


FIG. 9.—STEAM PIPE CONNECTIONS TO NEW ENGINES.

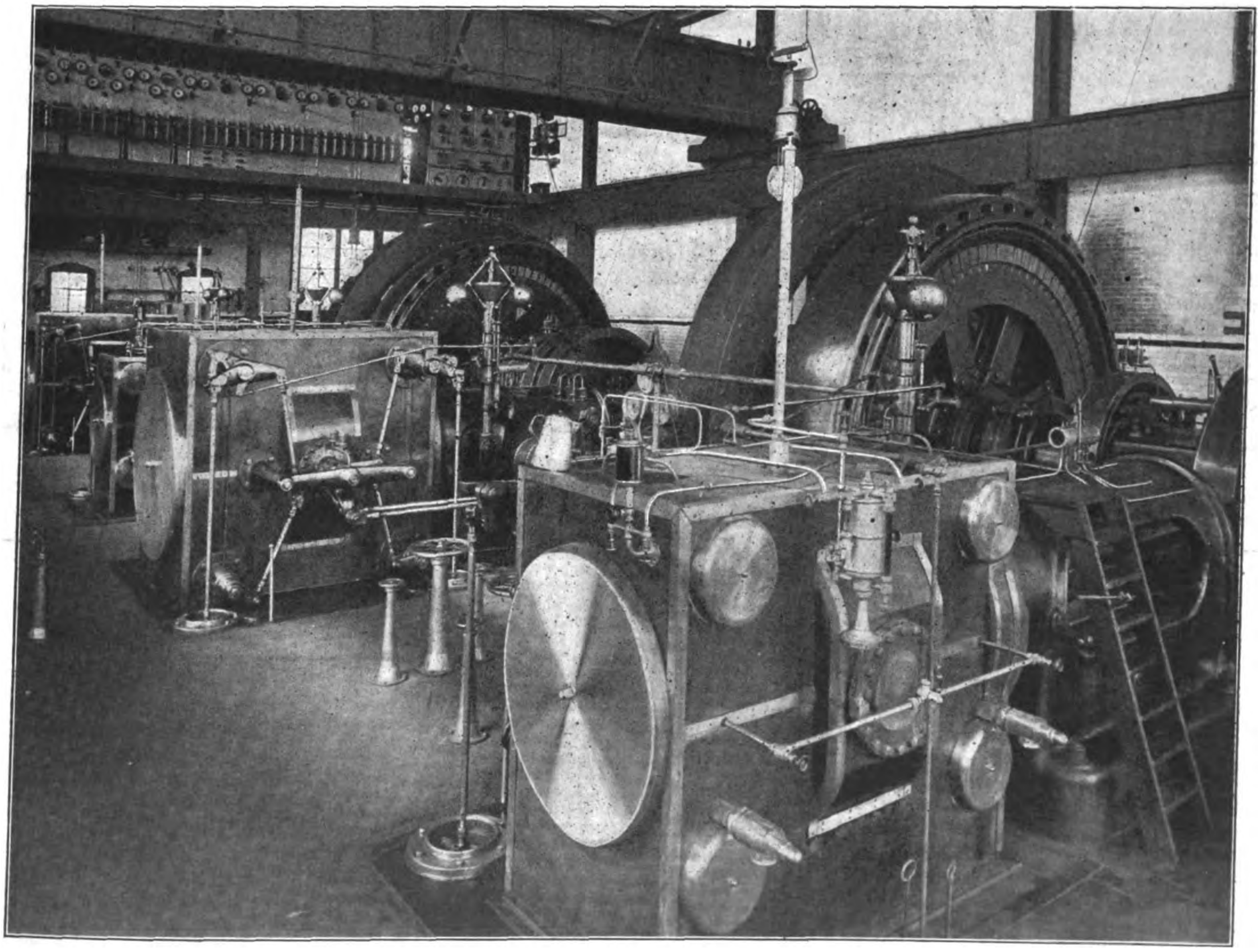


FIG. 10.—VIEW OF NEW ENGINE ROOM SHOWING THE TWO UNITS ALREADY INSTALLED.

The crank-shaft is made of fluid compressed steel bored out and forged hollow on a mandril and finished with a hole 8 ins. in diameter through the center. At the central portion, where the wheel and armature are located, the shaft is finished to a 24-in. diameter and then reduced in diameter to 20 ins. in the journals. This reduction is made with long fillets. The journals are 36 ins. long, and the main bearings are of the quarter box type. Both of the shells are water jacketed and lined with babbitt metal expanded into place. They are provided with oil channels to effect the distribution of oil over the entire surface of the journal, and the cover and top shell have three hand holes, so as to admit the hand direct to the shaft. The bottom shell is supported only at its center portion. The cranks are made of cast steel of the counter-balanced disc type polished on the face and edges, and pressed on the shaft and keyed in place.

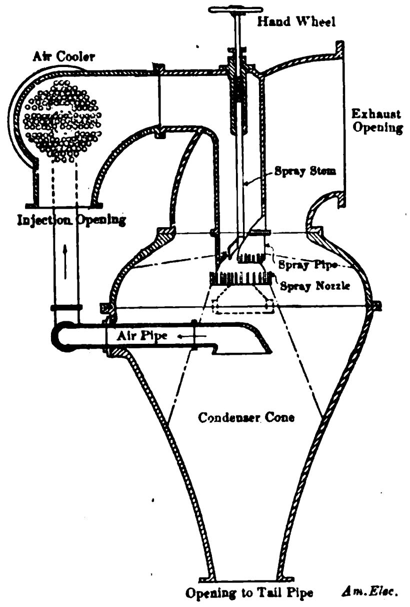


FIG. 11.—CONDENSER CONE.

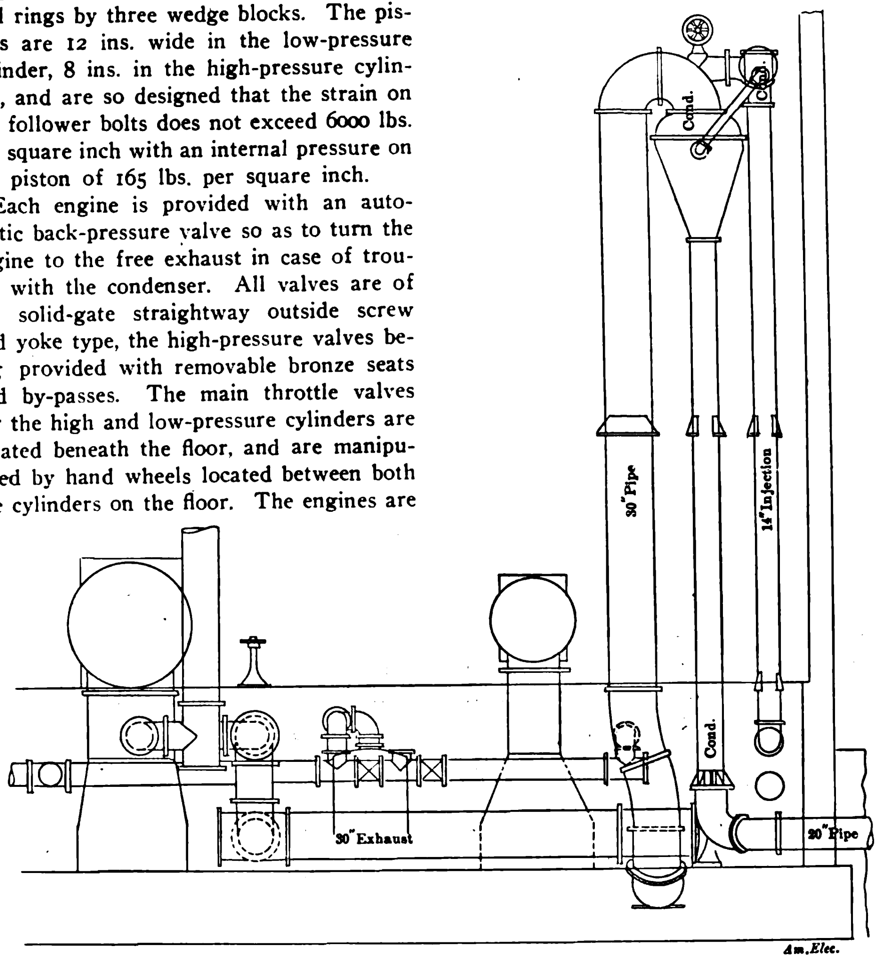


FIG. 12.—ELEVATION OF CONDENSER AND CONNECTIONS.

The flywheels are 20 ft. in diameter. The rim is of the built-up type, consisting of a cast-steel core with rolled steel plates breaking joints and riveted to the core. The wheel is very heavy, having 50 tons of metal in the rim. The arms and core of the rim are made of cast steel. The piston rods are made of open-hearth forged steel, being 6 ins. in diameter for both high and low-pressure cylinders. Each end is secured to the cross-head by a thread and steel jamb-nut, so that the clearance space in each cylinder may be equalized at any time. The stuffing boxes are provided with Tripp metallic packing, and the pistons are secured to the rods by steel jamb-nuts furnished with keepers to prevent their turning. Steel collars are placed between the pistons and shoulders on the piston-rods on the opposite side of the jamb-nuts. The pistons are heavily ribbed inside and have followers, bull and packing rings, the followers being so connected that the rings or any part may be inspected or replaced without removing the pistons from the cylinders or taking them from the rods. The pistons are provided with one center expansion ring 1½ ins. wide and loose bull rings, the pistons being supported from the bull rings by three wedge blocks. The pistons are 12 ins. wide in the low-pressure cylinder, 8 ins. in the high-pressure cylinder, and are so designed that the strain on the follower bolts does not exceed 6000 lbs. per square inch with an internal pressure on the piston of 165 lbs. per square inch.

Each engine is provided with an automatic back-pressure valve so as to turn the engine to the free exhaust in case of trouble with the condenser. All valves are of the solid-gate straightway outside screw and yoke type, the high-pressure valves being provided with removable bronze seats and by-passes. The main throttle valves for the high and low-pressure cylinders are located beneath the floor, and are manipulated by hand wheels located between both the cylinders on the floor. The engines are provided with a governor which the builders guarantee to govern the engine with a variation in speed during a revolution of over one-half of one per cent. under any condition of load up to the maximum of 2300 horse-power, and regulate between no-load and full-load up to 2500 horse-power when running under variable loads within one per cent in speed. An auxiliary regulator and rotating valve is provided entirely separate from the governor for emergency use. This is so designed that the steam will be entirely cut off from the engine in case the speed exceeds the normal speed by ten revolutions. The regulators are provided with oil dash-pots. Each engine is constructed to operate in multiple with any or all of the other engines.

In engine room No. 3 is also located a Westinghouse motor-generator set used as an exciter. This set is located beneath the stairway leading to the switchboard gallery and is shown by Fig. 13. It consists of a 160-h.p. two-phase induction motor driving a 125-volt 600-ampere direct-current generator at 585 r.p.m. A view of one of the engine-driven exciters in engine room No. 1 is given by Fig. 8.

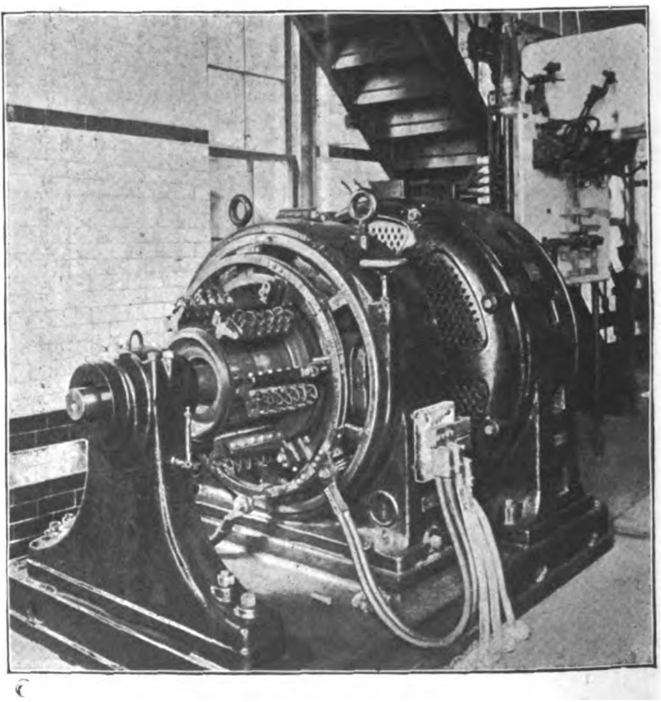


FIG. 13.—MOTOR-DRIVEN EXCITER UNIT.

The Worthington central condensing system is used on the newer engines, a Worthington elevated-type condenser being situated as shown in Fig. 12. A sectional view of the condenser cone is given in Fig. 11.

The cone is a combination of the old form of injector or barometric condenser with the modern form of jet condenser, except that it is so arranged that the air and circulating water are handled by independent pumps. The vapors from the cone are withdrawn from the air cooler, which is arranged in the injection piping and is kept cool by the circulating water from the main condenser. This cooler condenses the vapors and returns the condensation to the hot well, while the air goes to the vacuum pump dry. This permits the use of a positive-valve flywheel vacuum pump of the best type to maintain a high vacuum.

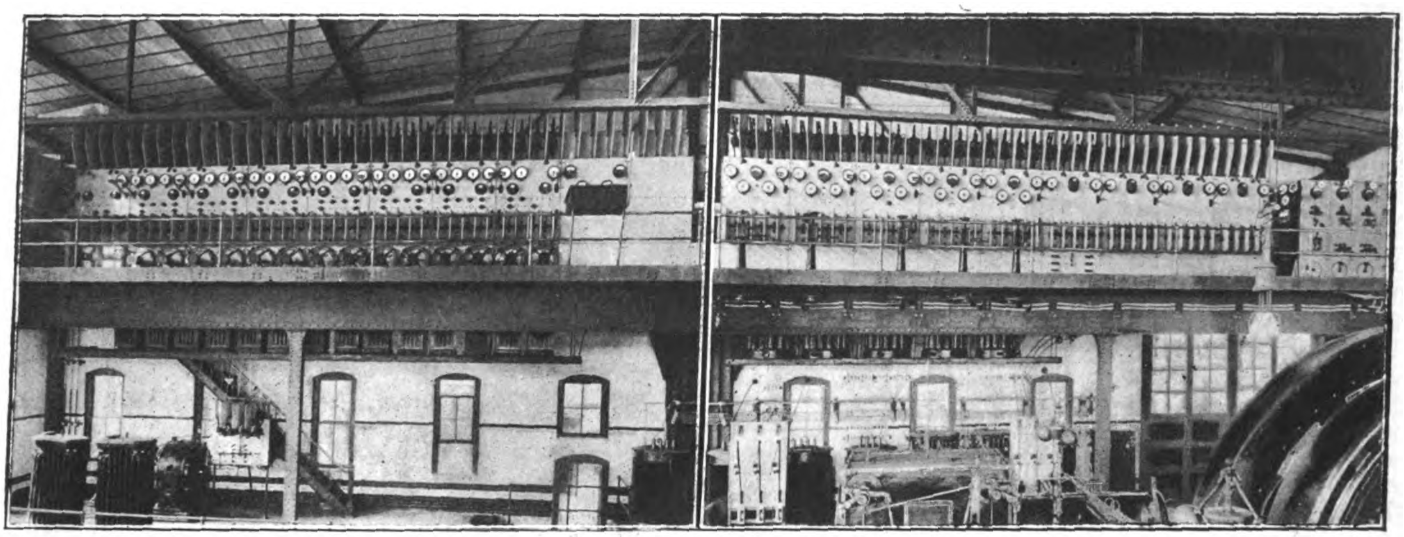


FIG. 14.—COMPOSITE VIEW OF ENTIRE MAIN SWITCHBOARD.

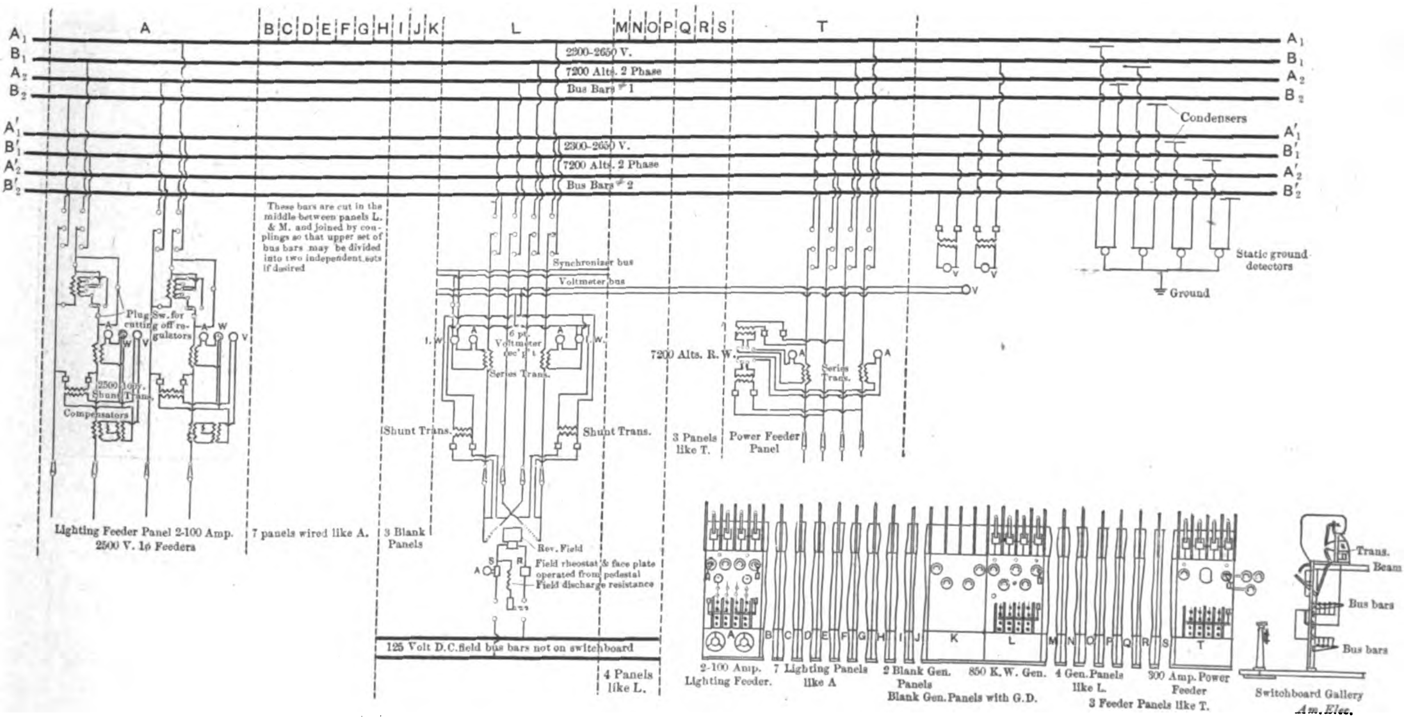

A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
A_1
B_1
A_2
B_2
A'_1
B'_1
A'_2
B'_2
2300-2650 V.
7200 Alts. 2 Phase
Bus Bars # 1
2300-2650 V.
7200 Alts. 2 Phase
Bus Bars # 2
These bars are cut in the middle between panels L. & M. and joined by couplings so that upper set of bus bars may be divided into two independent sets if desired
Plug Sw. for cutting off regulators
2500 100 V. Shunt Trans.
Compensators
W
V
Synchronizer bus
Voltmeter bus
6 pt. Voltmeter rec'p't
Series Trans.
Shunt Trans.
Shunt Trans.
Rev. Field
Field rheostat & face plate operated from pedestal
Field discharge resistance
125 Volt D.C. field bus bars not on switchboard
Lighting Feeder Panel 2-100 Amp. 2500 V. 1φ Feeders
7 panels wired like A.
3 Blank Panels
4 Panels like L.
7200 Alts. R. W.
Series Trans.
3 Panels like T.
Power Feeder Panel
Condensers
Static ground detectors
Ground
2-100 Amp. Lighting Feeder.
7 Lighting Panels like A
2 Blank Gen. Panels
Blank Gen. Panels with G.D.
850 K.W. Gen.
4 Gen. Panels like L.
300 Amp. Power Feeder
3 Feeder Panels like T.
Trans.
Beam
Bus bars
Bus bars
Switchboard Gallery
Am. Elec.

FIG. 15.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

The cooling water is supplied by a horizontal duplex direct-acting triple-expansion pump and is sprayed by a device which distributes the water in thin vertical sheets radially about the spray pipe shown in the center of the cone. This leaves the greatest amount of water surface in direct contact with the steam, the latter passing down from the top between the sheets of water and then passing away by the tail-pipe, which ordinarily stands 34 ft. above the hot well level in order to overcome the atmospheric pressure, but which in this case extends down to the river below the maximum low water mark. The cone is placed 34 ft. above the maximum high water mark. Should the vacuum be lost, an exhaust relief valve placed in the exhaust steam piping allows the exhaust steam to escape freely to the atmosphere. An entrainer, similar in form to a plumber's trap, but not deep enough to form a closed trap, forms the elbow connecting the horizontal exhaust main with the vertical exhaust pipe to the condenser cone. Its function is to collect any condensation in the horizontal exhaust header and enables the same to be carried up through the vertical exhaust pipe by the velocity of the exhaust steam.

An oiling system is installed which works on the gravity principle, the pressure being supplied from a tank of sufficient capacity located above the pump room and about 25 ft. above the elevation of the engine room floor. Supply mains are run from this tank to the several engines and are concealed beneath the floor except where they rise through the brass piping on each side of the engine, feeding the several cups. After the oil has run through the bearings it is carried from the engines by return pipes and gravity to a filter located in the cellar, whence after being filtered it is elevated by a pump to the supply tank. This system was installed by Westinghouse, Church, Kerr & Co.

A Westinghouse air compressor is installed in the basement of engine room No. 1, from which pipes are run connecting with the several outlets in the engine rooms. To these outlets is connected a flexible rubber hose through which compressed air is used for blowing dust and dirt out of the machines.

Special attention has been directed to the feed water system, the general outline of which is as follows: Two connections from two city water mains and emergency connections from the river are run to three feed-water pumps. The water is then pumped through Goubert heaters located between the Pennsylvania Iron Works Company's engines and their respective condensers, whence it runs through an auxiliary American heater located in the pump room. From this heater the piping system is run in a loop around either side of the boiler room, the system being so arranged with valves that any section may be cut out without affecting the rest of the piping. The connections with the two city mains are provided with check valves, so that if either main should burst, water from the other main would still be available.

The switchboard located on the gallery in engine room No. 3 was constructed and erected by the Westinghouse Electric & Manufacturing Company, and is of blue Vermont marble polished on both sides. Fig. 14 is a view of the main switchboard, and Fig. 15 is a diagram of the connections. The board, which contains 20 panels, was especially constructed for the United Electric Company. The circuit-breakers, which are all of the potential stick type, and automatic interlocking, are mounted on separate panels on top of the switchboard. There are six generator panels, each designed to control 1400 kilowatts. Two panels are left blank for future enlargement of the plant. The first two generator panels have mounted upon them the following apparatus: Two double-pole automatic alternating-current circuit-breakers, two standard round-pattern alternating-current ammeters, one standard round-pattern direct-current field ammeter, two Niagara type single-phase induction wattmeters, a four-pole dynamo selector switch which interlocks with a four-pole automatic circuit-breaker fitted with a time-limiting device, one voltmeter plug switch and receptacle, one ground detector fitted with a push, one plug ground detector and receptacle, two synchronizing plugs, two field plug switches, one alternating-current field rheostat, two shunt transformers and fuse blocks, and two series transformers. The remaining generator panels are similar to those detailed above, except that the ground-detector outfits are omitted. There are eight double-pole single-phase feeder panels, each of which controls two single-phase alternating-current feeders and has mounted on it the following apparatus: Two double-pole automatic alternating-current circuit-breakers, two ammeters, two compensating voltmeters, two single-phase integrating wattmeters, two Mershon compensators, two double-pole selector switches interlocking with automatic circuit-breakers fitted with time-limiting devices, two shunt transformers and fuse blocks, and two series transformers. A part of the station equipment not controlled from the switchboard proper comprises eight Stilwell regulators. These are connected in the circuits by means of a system of plugs so that if at any time it becomes desirable to disconnect the regulator from any one of the lighting feeders the plug may be inserted, thus short-circuiting the regulator. The rheostats and field switches for the alternating-current generators are mounted on pedestals located directly in front of the generator panels.

Four power panels are provided, each of which controls one four-wire three-phase power circuit and has mounted upon it the following apparatus: Two automatic circuit-breakers, two ammeters, two single-phase integrating wattmeters, one four-pole selector switch interlocking with a circuit-breaker connected with a time-limiting device, two series transformers, and four shunt transformers and fuse blocks. In addition to the apparatus specified above for the individual panels, there are for the entire switchboard three alternating-current voltmeters mounted on swinging brackets at the right end of the board; two of these are connected to the bus-bars and one is used for the generators. When looking at the board from the front the order in which the panels come, beginning from the right end, is as follows: Four power panels, six generator panels, space for two generator panels, and eight feeder panels. The exciter switchboard is mounted to the right and is entirely separate from the main operating board.

The entire design of the board is special with a view to meeting local conditions and embodies a number of distinctive features. One of the chief points always kept in view was to provide ample room in the rear of the board so that all wires, bus-bars and other apparatus might be kept distant from one another, so that there would be no liability to short-circuits, and at the same time facilitate the removal or replacing of apparatus while current was on the board without danger to the operator. Fig. 16 is a view showing a portion of the rear of the main switchboard. The bus-bars are insulated in the usual manner and in addition thereto are covered with a heavy magnesia pipe covering. All of the connecting wires are covered with a special fire-proof insulation made for this purpose. The reason for using the automatic type of circuit-breaker and the selector switches on the surface of the board was for simplicity in operation and also that the operator might see at all times the condition of his circuit.

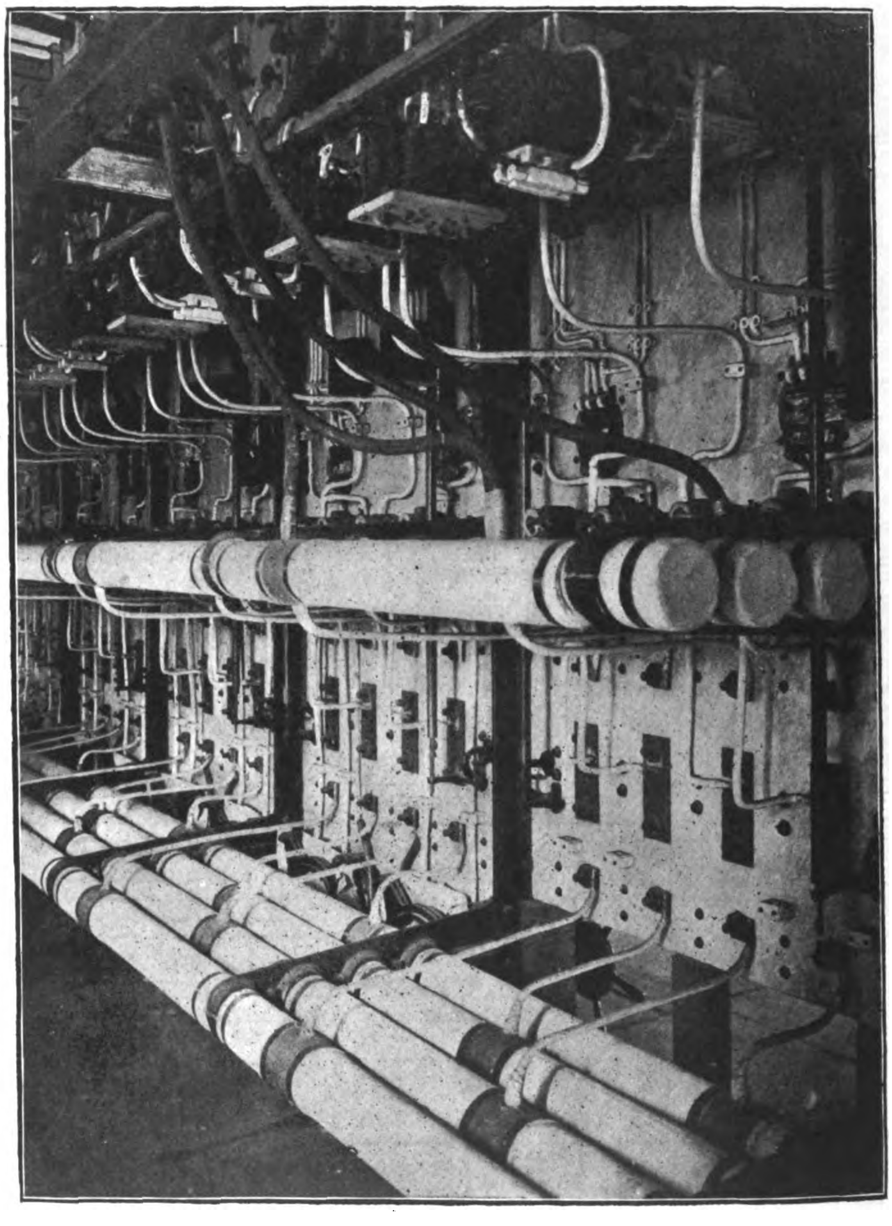


FIG. 16.—REAR VIEW OF MAIN SWITCHBOARD.

A sub-station is operated in connection with the river station, which is situated on Mechanic Street. The equipment consists of a three-wire 220-volt rotary converter fed by current delivered at the terminals of the transformers at 2200 volts and which is stepped down to the required voltage of the converter. The rotary converter is equipped with a Stillwell regulator which gives a range of direct-current voltage from 230 to 370 volts. There are also in service two 300-kw. 550-volt two-phase rotary converters supplying current for power service. These converters are supplied from the same line which supplies the other conveter. The usual alternating-current and direct-current rotary panels with distributing panels comprise the switchboard equipment.

The load carried by the station during last December was 256,942 kw.-hours on arc circuits with a maximum load of 1000 kilowatts; 505,220 kw.-hours on incandescent circuits with a maximum load of 2721 kilowatts, and 248,305 kw.-hours on power circuits. During July of this year the load carried was 441,022 kw.-hours on arc circuits; 743,912 kw.-hours on incandescent circuits, and 164,714 kw.-hours on power circuits. A portion of this current was transmitted to the Orange and Elizabeth stations of the company to help out these stations in times of heavy load. The transformers for stepping up the current from 2300 volts to 6000 volts for transmission to these stations are shown by Fig. 17 herewith. These are located in engine room No. 3, directly under the switchboard gallery. The maximum load on the arc and incandescent circuits was 1023 and 3557 kilowatts respectively. The increase in load on the incandescent circuits over the winter load on the same circuits was occasioned by the use of fan motors.

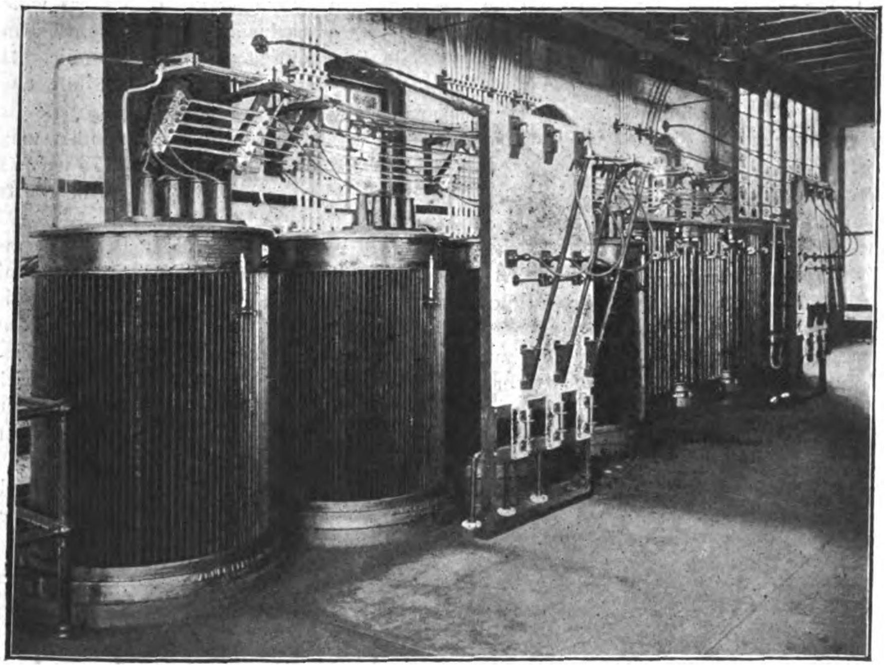


FIG. 17.—TRANSFORMERS FOR DELIVERING CURRENT TO ELIZABETH AND ORANGE, N. J.

All of the circuits are at present run overhead, but at this writing vitrified conduit and cable have been laid preparatory to putting the lines underground.

BEST MEANS OF ATTRACTING NEW ELECTRIC LIGHT CONSUMERS.

It is scarcely necessary to point out that this subject is one of the most important of the many that the practical central station manager must consider and handle judiciously in order to make a plant a success. The subject was somewhat fully discussed in the Question Box department at the recent convention of the National Electric Light Association. Mr. James W. Cartwright, of Bangor, Me., said that his experience indicated that the best means of attracting new consumers was reducing the rates. Each reduction he had made had within two months had the effect of largely increasing the gross earnings. If he could afford to stand the first reduction in earnings for a longer time he would put the price to a point that would enforce the use of electricity regardless of any price that the gas company could make.

Mr. E. H. Mather, of Portland, Me., made the following recommendations: 1st. Place lights and motors on separate generators and circuits. 2d. Make the regulation of the lighting circuits as near perfect as possible. 3d. Make the price as low as possible, allowing a reasonable interest on the capital invested. 4th. Present the advantages of the electric light to the public through capable solicitors.

Mr. Ralph J. Patterson, of Waterville, Me., like Mr. Cartwright, thought that the best method of attracting new consumers was to reduce the price of the service, if it could be done. The plan used by telephone companies, of giving three or four months' service free, has also been very successful, and is a method that would probably appeal to central station men as being better than any permanent reduction in rates. If the former plan is attempted it must be done with a good understanding of the conditions under which electricity is produced and used, or the effect might be disastrous. In the latter plan it is simply a matter of making a plain statement to consumers.

Mr. Chas. H. Peters, of the Durango Light & Power Company, recommended a perfect service at a reasonable price, and selling fixtures almost at cost. No matter how cheap light may be, he said, if the service is poor it is very difficult if not impossible to increase the number of customers at a satisfactory rate. By selling fixtures at almost cost one will find two or three lights often burning in a place where a single drop light would have been made to answer otherwise. A well-lighted room is a standing advertisement by which the company will gain. Give a new lamp for every four or five dollars' worth of current consumed; this will insure the laying aside of blackened globes, and give the customer the candle-power he pays for. Courtesy upon the part of all employees is important; an insolent or discourteous man should not be tolerated.

According to Mr. H. W. Taylor, of Gardner, Mass., the best way to attract new customers is to make the old customers so well satisfied with the quality of the light and power, the reasonableness of the rates and the honesty and courteous treatment of the local manager, that they shall proclaim to all their friends the satisfaction which they feel. This kind of advertising will give better and more lasting returns than any amount of talk or display by those whom the solicited persons know to be directly interested.

Following the reading of the foregoing expressions of opinion, which had been deposited in the Question Box in written form, President Doherty related an experience that he had two years previously in starting a new station. Instead of adopting any of the methods outlined in the written answers to the question, he offered a premium to wiremen for every lamp wired up. The result was that in a town of 80,000, where competition is strong, the company had, within the two years of its existence, wired up 42,000 incandescent lamps. Mr. Arthur Williams, of the New York Edison Company, expressed the opinion that the value of a strong nucleus of wiring contractors could scarcely be overestimated. In a small place where there would seem to be little work for contractors to do, he thought that much business could be developed by encouraging the contractors to get just as much business as they could, and then let them alone and allow them to make as much money as they could.

◆ ◆ ◆

Unique Distribution System—A system, which exactly reverses the usual method of distributing electricity is in use on a 35-mile transmission line between Lausanne and St. Maurice, Switzerland. A water-power generating station of 5000 horse-power capacity at St. Maurice generates direct current at a pressure of 23,000 volts, which is transmitted to Lausanne, where it is converted into polyphase alternating current by motor-generator sets for local distribution. The high-tension current is obtained by connecting ten dynamos in series, and the motors of the motor-generators at the receiving end are similarly connected.

TELEPHONE ENGINEERING

BY FRANZ J. DOMMERQUE.

ROUTES FOR COUNTRY LINES.

Selecting a route in the country for the purpose of toll or long-distance service, sometimes involves difficulties, as there may be several routes to choose from. It is always preferable to have the route along a highway on account of easier accessibility, and it is worth some additional expense to accomplish this. But there are cases where it would require too great an outlay of money to follow highways, as for instance, when the road passes over mountains or hills, where the rocks are right on the surface. In such cases recourse would have to be taken to blasting the holes for the poles, which would make the cost of the pole line enormous. In such a case it would probably be without exception advisable to find a route around the rocky elevation which would be considerably longer, but cheaper on the whole.

Then it may occur that a pole line leads to a river that cannot be spanned, and as the use of cables in toll and long-distance lines is not advisable, it would be necessary to follow the river to the nearest bridge. Lakes that are in the route of the pole line will have to be skirted.

When there are several routes to select from, all being along highways, the cost of each route should be estimated and the cheapest one chosen, even if it is not the shortest. When calculating the cost of a pole line, it is advisable to estimate on 5400 feet of wire to the mile, as this will allow for the sag in the wire, unevenness in the lines, loss in joints, etc.

SECURING THE RIGHT OF WAY.

In large or medium-sized cities, as stated before, the right of occupying the streets and alleys by conduits and pole lines is usually given with the franchise and special permits from the city authorities are only obtained in particular cases of extensions, the abutting property owners being left out of consideration, except in private alleys, where the telephone company will have to make private arrangements. Difficulties are mostly met in villages along country roads and across farms. In such cases, the following may serve as a guide:

Having planned the location of the main pole lines and secured an option on suitable rooms for an office in a building situated at one of the four corners where these two main pole lines cross at right angles, the next step is to have the city engineer or the street committee approve the pole locations selected by the company on every street that will in all probability be occupied during several years to come. This is usually a far more difficult task than appears at first thought. Ten owners of handsome homes may offer no objection to poles being placed in front of their property, while an eleventh owner may be opposed to all innovations, and too stubborn to be convinced by reasoning. The only course left open with the street committee is to plainly tell such a property owner that when the street was ceded to the city all control passed from the hands of the property owners to the municipal authorities, and that the courts have decided that the company has a perfect right to set poles at points located by the street committee, regardless of the wishes of the property owner.

Securing right of way across private property and along country highways is work of an entirely different character from securing locations for poles on city streets. He who undertakes this work should be a good judge of human nature, possess inexhaustible patience and tireless persistency, and be fully posted on the rights of property owners. A fair knowledge of farm customs and of the habits, value and breeding of horses, cattle, fowls, etc., may serve as an excellent introduction and smooth the way to a successful understanding. Where a frank statement of the situation and a reasonable cash offer fails to secure the desired right of way under reasonable conditions, then a well thought out game of bluff may succeed, provided the right of way man understands the science of bluffing to the end of the game. Some telephone companies pay for the right of way privileges with free telephone service, but this is a questionable practice. A cash arrangement will be more satisfactory in the long run, especially when the papers are drawn up in the form of a claim for damages and permanent possession is ceded.

As country lines rarely follow the highways for long distances at a stretch, but leave the highway and cross over private property in order to reduce distances, and then return to the highway, complete right of way for the entire route should be secured before any construction work is undertaken. To do otherwise will be found an expensive experiment.

The usual rates paid for right of way privileges vary with the locality and surrounding conditions, but should average about $50 per mile, including all expenses incurred in securing every privilege. The contract for clearing right of way as wide as possible on each side of a 10-pin cross-arm should be made at about $10 a mile. It should be borne in mind that while one farmer may charge only five cents a pole for right of way across his farm, another may demand fifty cents a pole and act so ugly as to render it necessary to apply to the courts to condemn the right of way.

It will readily be perceived that the conditions likely to arise in securing right of way privileges may vary so widely that it is difficult to give definite instructions that would fit all cases. Experience is the best teacher. Under her guidance, coupled with a fair knowledge of the law on the subject, a sensible and practical man of affairs can easily succeed where others would fail.

A formal contract reading about as follows, should be entered into for the protection of both parties to the agreement:

No...............

Line between.. and ....

Approx. No. of
Line Poles.....
Guy Poles.....
Anchors........
....
....

$..................... Received of ***THE*** .... ***TELEPHONE COMPANY,***

....in consideration of which............hereby grant unto said Company, its successors and assigns, the right to construct, operate and maintain its lines, including the necessary poles, fixtures and wires over and along the property which........................own or in which......................have any interest in the ....County of .... and State of ....and also along the roads, streets or highways adjoining the property owned by...........said sum received in full payment for such right, and in full satisfaction for the trimming of any trees along said lines necessary to keep the wires cleared at least eighteen inches, and with the right to set the necessary guy and brace poles, and attach to trees the necessary guy wires.

....

....

....

....

Date.. ....
LAND OWNER.

....
POST OFFICE ADDRESS LAND OWNER.

Correct.........................

SYNCHRONOUS COMMUTATING MACHINES.

DISTRIBUTION OF CURRENT IN ARMATURE WINDINGS AND RELATIVE CAPACITIES COMPARED TO DIRECT-CURRENT GENERATOR AS UNITY. UNIT POWER FACTOR.

BY A. S. M'ALLISTER.

The term "synchronous commutating machines" refers to all motors or generators which receive or deliver both alternating and direct current. The machines discussed below are rotary converters and double-current generators, and comparisons are made with the capacities of alternating-current generators of different number of phases.

For simplicity in treatment, the rotary converters are assumed to deliver at the direct-current commutator all energy received at the alternating end; that is, the output is assumed equal to the input in determining the relative currents on each side, though, as will be seen later, the armature copper loss is properly accounted for. The double-current generators are assumed to deliver equal amounts of energy at the commutator and at the collector rings. The assumption is further made that the alternating-current wave in each case follows a true sine curve of time-value.

In a rotary converter the mean flow of alternating current is in a direction opposed to the flow of the direct current, but the absolute value of the alternating current varies from time to time and the direct current reverses direction of flow through the individual coils as each passes under one of the brushes, so that the resultant current in the coils varies both in value and direction of flow from instant to instant and, in general, it has not the same heating effect in different armature coils.

When the alternating current has unity power factor, the maximum value of the current, evidently, occurs when the group of coils of the phase under consideration are developing their maximum e. m. f. The mechanical position of the coils at this instant of maximum e. m.f. is that in which the center of the group of coils is passing at right angles to the lines of force from a field pole—with a non-distorted field this position would be opposite the center of the field pole. When the coils are passing parallel to the lines of force the e. m. f. is of course zero. At intermediate positions, the value of the e. m. f. may be represented by $E_m \cos \theta$, where E_m represents the maximum e. m. f. and θ the angle between the instantaneous position of the coils and a line from the pole center to the center of the armature shaft.

The absolute value of the maximum e. m. f. depends upon the number of coils in the group considered. While the effective value of the e.m.f. developed in each coil is the same as that in the others, and adjacent coils are connected in series, the effective value of the e. m. f. of a group of coils is not proportional directly to the number of coils composing a group, since the e. m. f. of one coil is not directly in phase with that of the adjacent coils; that is, the e. m. f. of each coil reaches its maximum value at a different instant from that corresponding to the maximum e. m. f. of each of the other coils.

If time be represented as angular degrees passed over by the armature of a bipolar machine, and the value of the e. m. f. of each individual coil be denoted by a line of any chosen length, and the line for each coil be placed in the angular-time position which the armature would occupy when that coil has its maximum e. m. f., a diagram similar to that represented by Fig. 1 will be produced. Here *o1* represents the effective value and time position of coil No. 1, and *o2* represents corresponding quantities for coil No. 2, etc. As stated above, these coils are connected in series, so that the actual effective value of the e. m. f. of the coils as interconnected may be represented as in Fig. 2. It will be observed that as the number of coils is increased the figure approaches a circle and that in any case the extremities of the sides lie on a circle.

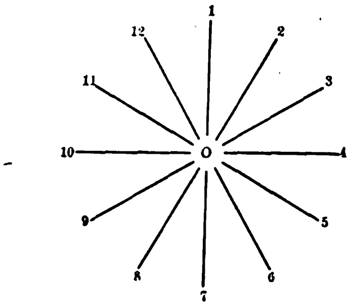


FIG. 1.

By the use of the figure below or equivalent circle it is a simple matter to determine the effective value of the e.m. f. of a group of coils on an armature. This e. m. f. is seen to be represented in value by the chord of the arc subtended by the group of coils. If the total number of coils on the armature be divided into P equal parts, then the angle covered by each part is $360° \div P$; and, since the chord is equal to twice the sine of half the angle, the e. m.f. of each group is

$$E_p = 2 \frac{E}{2} \sin \frac{180°}{P} = E \sin \frac{180°}{P}$$

where E is the value of the e. m. f. measured across a diameter. Now, E is the effective value of the e. m. f. at the diameter, while for a rotary converter the direct-current commutated e.m.f. is equal to the maximum value of this e. m. f., or is $\sqrt{2}\,E = E_m$. Therefore, the effective maximum value of the e.m.f. of a group of coils which cover $\frac{1}{P}$ part of the armature is equal to

$$\frac{E_m}{\sqrt{2}} \sin \frac{180°}{P} = E_p$$

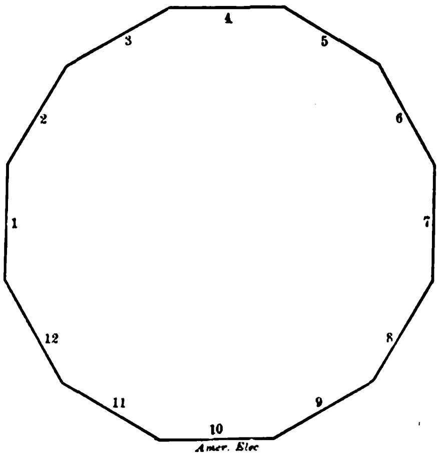


FIG. 2.

When the alternating current is in phase with the e. m. f., the product of the current flowing in the coils selected, by the e. m. f. across the group gives the energy in watts in that section of the armature and when the armature is symmetrically loaded, the total energy is

$$W = P\,I_p \frac{E_m}{\sqrt{2}} \sin \frac{180°}{P}$$

For the purpose of later comparing capacities of alternating-current machines of various types and phases, it is convenient at this point to ascertain, by means of the above formula, the relative capacities of a closed-coil armature used in a direct-current generator and the same armature used in alternating-current generators of different number of phases. Consider the armature to revolve in a field of constant intensity at a constant speed. There will be generated the same e. m. f. per conductor irrespective of connections of the external circuits. Assume that the capacity is in each case wholly determined by the heating of the armature conductors and, as a method of direct comparison, assume that the external load is so adjusted in each case that there flows the same current through each conductor on the armature whether used in a direct or an alternating-current generator and independent of the number of phases. Obviously, the loss from heating of the armature conductors will always remain the same, while the capacity will vary as the external load.

For simplicity in comparison, assume that there flows always 5 amperes in each armature conductor, and also that the e.m.f. measured between the direct-current brushes is 100. The capacity as a direct-current generator is evidently 1000 watts, while the outputs as alternating-current generators of various numbers of phases will be as in Table I. (See also Fig. 3.)

TABLE I.
Capacities of Alternator Compared to Direct-Current Generator as 1000.

Number of Phases.	Volts Between Leads.	Amperes Per Phase.	Total Output.	Amperes Per Lead.
	$\frac{\text{Sin}}{\sqrt{2}} \times \frac{180}{P}$		$P\,E_P\,I_P$	$\frac{2\,W_t}{70.71\,P}$
P	E_P	I_P	W_t	I_L
2	70.71	5	707.1	10.00
3	61.24	5	918.6	8.66
4	50.00	5	1000.0	7.07
6	35.35	5	1060.6	5.00
Infinite	0.+	5	1110.7	0.+

When $P =$ infinity, $E_p = 0$, but $P\,E_p = 100 \times \sqrt{1/2} \times \pi$, as will be shown later.

It is interesting to note that the capacity of an alternating-current generator can be represented as the perimeter of a polygon having sides equal in number to the number of phases, of which polygon the circumscribing circle represents the capacity for

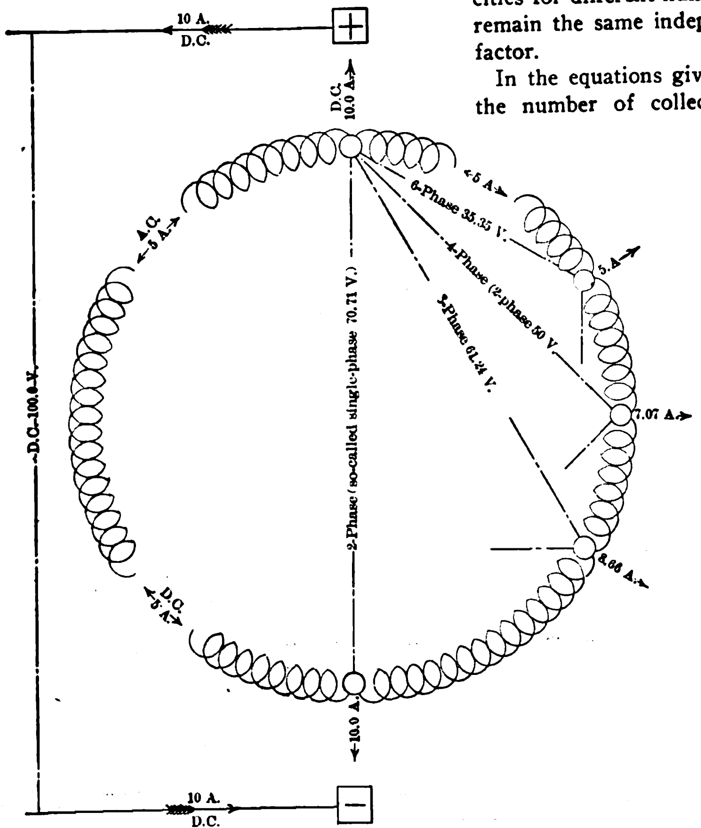


FIG. 3.—RELATIVE CURRENTS FOR SAME HEAT LOSS IN CLOSED COIL GENERATOR ARMATURE.

infinite phases, the diameter of this circle representing the capacity of the so-called single-phase generator, while the capacity of the machine as a direct-current generator is represented in value by the perimeter of a square inscribed within the circle. These facts will be brought out by an inspection of Fig. 3.

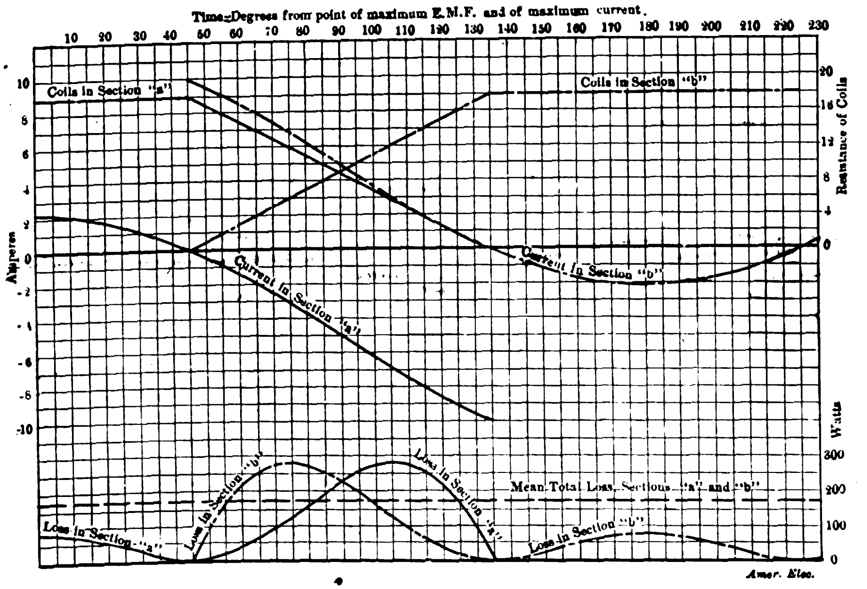


FIG. 5.—DISTRIBUTION OF LOSS IN ARMATURE OF A FOUR-PHASE SYNCHRONOUS CONVERTER, THE ANGLE OF LAG BEING ZERO.

It is to be observed that the output given above is the volt-ampere capacity of each machine. With an alternating-current generator, the energy delivered will, of course, vary with the power factor. At any power factor less than unity the ratio of the alternating to the direct-current capacities would vary directly therewith, but the ratio of the alternating-current capacities for different numbers of phases would remain the same independent of the power factor.

In the equations given, P corresponds to the number of collector rings. Thus, a closed-coil single-phase generator, so-called, is considered a two-phase generator, the phases being 180° apart. A so-called two-phase generator having a closed-coil armature with four collector rings is, in fact, a four-phase generator with phases 90° apart, though its capacity is neither increased nor decreased by loading as two separate two-phase (so-called single-phase) generators.

The problem of determining the relative capacities of rotary converters and other synchronous commutating machines can be attacked by use of the same fundamental equation developed above as applied to the alternating-current generators, though the method of application must be slightly modified to suit the various types of machines. Perhaps the simplest method of ascertaining the effect of the presence of both the direct and the alternating current upon the relative copper loss of the armature is to compare the losses of different machines for assumed equal outputs, and then to determine the relative outputs for the same loss.

The formula referred to above enables one to determine at once the effective value of current which is necessary to give a certain amount of power when P, the number of phase, and E_m, the direct-current e.m.f. are known. Table II gives the value of current for various number of phases for an assumed power of 1000 watts and direct-current e. m. f. of 100 volts.

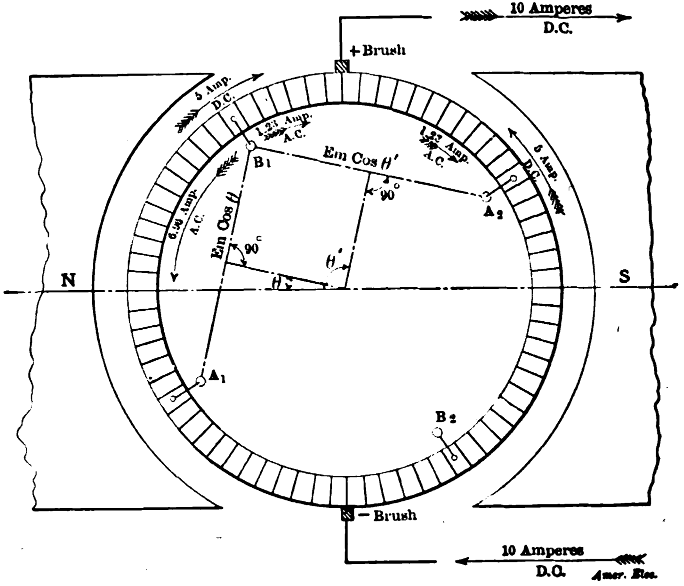


FIG. 4.—DISTRIBUTION OF CURRENT IN ARMATURE CONDUCTORS OF A FOUR-PHASE SYNCHRONOUS CONVERTER.

TABLE II.

Volts and Amperes for Same Energy with Different Numbers of Phases.

Number of Phases.	Volts Between Leads.	Amp. per Phase; Effective.	Amp. per Phase; Max.	Amp. per Lead; Effective.
P	$\frac{\sin\frac{180}{P}}{\sqrt{2}} = E_P$	$\frac{W}{P.\ E_P} = I_P$	$\sqrt{2}\, I_P = I_M$	$\frac{\sqrt{2}\, W}{P.\ E} = I_L$
2 (single-phase)	70.71	7.071	10.000	14.142
3	61.24	5.443	7.698	9.428
4 (two-phase)	50.00	5.000	7.071	7.071
6	35.35	4.714	6.665	4.714
Infinite	0.+	4.501	6.365	0.+
D. C. App. 2	E = 100	$\frac{I}{2} = 5.0$	$\frac{I}{2} = 5.0$	I = 10

It is to be noted that as the number of phases increases the current per group of coils decreases, but that, even with an infinite number of phases, the current has yet a finite value. An inspection of Fig. 3 will show that the total e. m. f. of the infinity groups of infinity phases is represented by the circumference of the circumscribing circle. The value of current to produce the assumed power is found by dividing the 1000 watts by this total e. m. f.

The maximum value of current for sine waves is $\sqrt{2}$ times the effective value and, when the power factor is unity, this maximum current flows when the coils are developing their maximum e. m. f. With an armature in a bipolar field, as shown in Fig. 4, the maximum value of e. m. f. in a group of coils occurs at that position of the revolution of the armature where the line joining the extremities of the group is in a vertical plane, and the e. m. f. in other positions varies as the cosine of the angle of deviation from this vertical position.

Having determined the value of the maximum alternating current and the position of the group of coils when this maximum flows it now remains to investigate the effect of the presence of the direct current in the armature coils.

For purpose of combined generality of treatment and simplicity of discussion, the so-called single-phase rotary will be omitted for the present and there will be discussed first the so-called two-phase machine which is in reality a four-phase rotary converter. Since there are four phases, the group of coils for each phase covers 90 degrees. Assume that there are 72 coils on the armature. There will then be 18 coils per phase, and each coil covers 5°. (The treatment here given is general and results will be in no way affected if the 5° contain any number of coils, or in fact, less than one coil.)

Consider the instant when the group of coils is in the position of generating maximum e.m. f., as indicated in Fig. 4. The alternating current is equal to $\sqrt{2}\,I = 7.071$, while the direct current is $500 \div 100 = 5$, so that the actual current flowing through the coils is 7.071—5, causing a relative loss of $(2.07)^2 \times 18 = 77$, where the resistance of each coil is taken as unity.

As the armature moves forward 5° the alternating current drops to $7.071 \cos 5° = 7.05$, while the direct current remains at 5, causing a relative loss of $(2.05)^2 \times 18 = 76$. In this manner the relative loss for each position of the armature may be determined up to that number of degrees rotation which brings the beginning of the group of coils under the + brush. When the armature has rotated 50° one coil of the group considered will be on the right of the brush, and, though this coil has the same value of alternating current in it as has each of the others of the group, the direct current through it is reversed and the resultant current is, therefore, greater than in the other coils or is equal to $4.55 + 5 = 9.55$, causing a relative loss of $(9.55)^2 \times 1 = 91.2$. The other coils have at this instant a resultant current of 4.55—5 and a relative loss of $(-.45)^2 \times 17 = 3.4$, hence the total relative loss for the group is $91.2 + 3.4 = 94.6$.

As the armature continues to rotate more coils pass into the right-hand section and less remain in the left-hand section, till, when the armature has rotated 90° from its initial position, the coils are equally divided between the two sections—one-half on each side of the brush. At this instant the alternating current will have decreased to zero and the total relative loss will be 450, which is the loss due to the direct current alone.

Continuing this investigation till the armature has rotated 180°, it will be plain that the conditions obtained at the beginning are being repeated, so that a mean of the total relative losses throughout the 180° is the same as occurs continuously throughout the operation of the rotary. As shown by Table III, this mean relative loss is 170, for the conditions herein assumed. The relative loss for the group of coils if the machine were operating as a direct-current generator would be 450, as found above. The relation between these, 1 to 2.647, indicates the relative loss of the four-phase rotary converter compared with the corresponding direct-current generator, at the same output, as unity. Since the loss in any circuit varies as the square of the current, the relative currents to give the same loss should vary as the square root of the above ratio, or the relative capacities of the machine as a rotary and as a direct-current generator will be $\sqrt{2.647} = 1.627$.

An inspection of columns 4 and 5 of Table III or of equivalent curves of Fig. 5, reveals the manner in which the instantaneous value of current in the coils varies. It will be seen that, though the mean effective

TABLE III.—FOUR-PHASE SYNCHRONOUS COMMUTATING MACHINES. ANGLE OF CURRENT LAG = 0°. POWER FACTOR UNITY.

ROTARY CONVERTER.												DOUBLE CURRENT GENERATOR.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Time from maximum current.	Cosine of time angle.	Instantaneous value of alternating current.	Current in section a.	Current in section b.	Coils in section a.	Coils in section b.	Relative loss in section a.	Relative loss in section b.	Total relative loss.	Relative loss in coil No. 1.	Relative loss in coil No. 9.	Current in section a.	Current in section b.	Relative loss in section a.	Relative loss in section b.	Total relative loss.	Relative loss in coil No. 9.	Relative loss in coil No. 1.
θ	cosθ	Icosθ	I_a	I_b	R_a	R_b	$I_a{}^2R_a$	$I_b{}^2R_b$	I^2R	$I_1{}^2 R_{14}$	$I_9{}^2 R_9$	I_a	I_b	$I_a{}^2 R_a$	$I_b{}^2 B_b$	I^2R	$I_9{}^2 R_9$	$I_1{}^2 R_1$
0	1.0000	7.07	2.07	...	18	0	77	0	77	4.38	4.38	12.07	...	2620	0	2620	146.0	146.0
5	.9962	7.05	2.05	...	18	0	76	0	76	4.21	4.21	12.05	...	2615	0	2615	145.5	145.5
10	.9848	6.96	1.96	...	18	0	69	0	69	3.84	3.84	11.96	...	2570	0	2570	143.0	143.0
15	.9659	6.83	1.83	...	18	0	61	0	61	3.34	3.34	11.83	...	2521	0	2521	140.0	140.0
20	.9397	6.64	1.64	...	18	0	48	0	48	2.68	2.68	11.64	...	2440	0	2440	135.5	135.5
25	.9063	6.41	1.41	...	18	0	36	0	36	1.99	1.99	11.41	...	2350	0	2350	130.5	130.5
30	.8660	6.12	1.12	...	18	0	23	0	23	1.26	1.26	11.12	...	2235	0	2235	124.0	124.0
35	.8192	5.79	.79	...	18	0	11	0	11	.62	.62	10.79	...	2100	0	2100	116.2	116.2
40	.7660	5.42	.42	...	18	0	3	0	3	.18	.18	10.42	...	1962	0	1962	108.7	108.7
45	.7071	5.00	.00	10.00	18	0	0	0	0	50.00	.00	10.00	.00	1800	0	1800	100.0	50.0
50	.6428	4.55	.45	9.55	17	1	.3	91	94	91.20	.20	9.55	.45	1552	0	1552	91.2	.2
55	.5736	4.06	.94	9.06	16	2	14	164	178	82.10	.88	9.06	.94	1315	2	1317	82.1	.9
60	.5000	3.54	1.46	8.54	15	3	32	218	250	73.05	2.13	8.54	1.46	1092	6	1098	73.0	2.1
65	.4226	2.99	2.01	7.99	14	4	57	255	312	63.80	4.04	7.99	2.01	892	16	908	63.8	4.0
70	.3420	2.42	2.58	7.42	13	5	87	275	362	55.00	6.66	7.42	2.58	715	33	748	55.0	6.7
75	.2588	1.83	3.17	6.83	12	6	121	280	401	46.60	10.05	6.83	3.17	560	60	620	46.6	10.0
80	.1736	1.23	3.77	6.23	11	7	157	272	428	38.75	14.21	6.23	3.77	427	100	527	38.8	14.2
85	.0872	.62	4.38	5.62	10	8	192	252	444	31.60	19.20	5.62	4.38	316	154	470	31.6	19.2
90	.0000	.00	5.00	5.00	9	9	225	225	450	25.00	25.00	5.00	5.00	225	225	450	25.0	25.0
95	.0872	.62	5.62	4.38	8	10	252	192	444	19.20	19.20	4.38	5.62	154	316	470	31.6	31.6
100	.1736	1.23	6.23	3.77	7	11	272	157	428	14.21	14.21	3.77	6.23	100	427	527	38.8	38.8
105	.2588	1.83	6.83	3.17	6	12	280	121	401	10.05	10.05	3.17	6.83	60	560	620	46.6	46.6
110	.3420	2.42	7.42	2.58	5	13	275	87	362	6.66	6.66	2.58	7.42	33	715	748	55.0	55.0
115	.4226	2.99	7.99	2.01	4	14	255	57	312	4.04	4.04	2.01	7.99	16	892	908	63.8	63.8
120	.5000	3.54	8.54	1.46	3	15	218	32	250	2.13	2.13	1.46	8.54	6	1092	1098	73.0	73.0
125	.5736	4.06	9.06	.94	2	16	164	14	178	.88	.88	.94	9.06	2	1315	1317	82.1	82.1
130	.6428	4.55	9.55	.45	1	17	91	3	94	.20	.20	.45	9.55	0	1552	1552	91.2	91.2
135	.7071	5.00	10.00	.00	0	18	0	0	0	.00	.00	.00	10.00	0	1800	1800	100.0	100.0
140	.7660	5.42	...	.42	0	18	0	3	3	.18	.18	...	10.42	0	1962	1962	108.7	108.7
145	.8192	5.79	...	.79	0	18	0	11	11	.62	.62	...	10.79	0	2100	2100	116.2	116.2
150	.8660	6.12	...	1.12	0	18	0	23	23	1.26	1.26	...	11.13	0	2235	2235	124.0	124.0
155	.9063	6.41	...	1.41	0	18	0	36	36	1.99	1.99	...	11.41	0	2350	2350	130.5	130.5
160	.9397	6.64	...	1.64	0	18	0	48	48	2.68	2.68	...	11.64	0	2440	2440	135.5	135.5
165	.9659	6.83	...	1.83	0	18	0	61	61	3.34	3.34	...	11.83	0	2521	2521	140.0	140.0
170	.9848	6.96	...	1.96	0	18	0	69	69	3.84	3.84	...	11.96	0	2570	2570	143.0	143.0
175	.9962	7.05	...	2.05	0	18	0	76	76	4.21	4.21	...	12.05	0	2615	2615	145.5	145.5
180	1.0000	7.07	...	2.07	0	18	0	77	77	4.38	4.38	...	12.07	0	2620	2620	146.0	146.0
185	.9962	7.05	...	2.05	0	18	0	76	76	4.21	4.21	...	12.05	0	2615	2615	145.5	145.5
Mean.—Omitting Duplicates.									170	18.19	5.01					1631.6	95.0	81.66

value of current for the group of coils is less as a rotary than as a direct-current generator, there are certain coils which at certain times carry more current than others and that one coil will carry a maximum of twice the current when operating as a four-phase rotary as a direct-current generator.

In a subsequent article will be discussed the effect that such maximum current has upon the distribution of heat loss in the armature windings and an investigation of the capacities of rotary converters and double-current generators under fractional power factor will be pursued.

Some Engines and Generators at the Düsseldorf Exposition.

The Industrial and Trades Exposition now being held in Düsseldorf, Germany, presents many interesting and instructive features. It was planned to show the commercial industries of Rhenish Prussia and Westphalia, but it gives an excellent idea of the growth of trade and of the progress in mechanical arts throughout Germany. The exhibition grounds are located at the outskirts of the city of Düsseldorf along the northern bank of the river Rhine.

One of the important electrical firms now coming to the front in Germany is that known as the Rheydt Electrotechnical Works, Max Schorch & Co. Some excellent exhibits have been sent to the exposition by this concern. Fig. 2 shows a polyphase alternator direct-connected to a vertical compound engine built by the firm of Robt. Spies Fr. Sohn, of Barmen-Leimbach. This unit operates at 143 r. p. m., and supplies three-phase currents at 5000 volts, the current per phase being 40 amperes and the total capacity 350 kilowatts. The total diameter of the generator is 3872 millimeters. There are 252 slots in the armature core, two per pole per phase, and the dimensions of each slot are 17½ mm. x 30 mm. (.69 x 1.18 ins.). Each slot contains ten conductors four mm. (.1575 in.) in diameter, placed in micanite tubes with walls four mm. thick. The resistance per phase is 0.82 ohm cold and 0.935 ohm warm; the winding is connected up star or Y fashion.

The field magnet ring of this machine is 3500 mm. (11½ ft.) in outside diameter and has 42 poles of Siemens-Martin steel, with pole-shoes 250 mm. (9.84 ins.) wide. The field winding consists of 85 turns of rectangular conductor, 5 x 6 mm. (.197 x 236 in.), and the resistance of the winding is 1.5 ohms cold and 1.7 ohms warm, the coils being all connected in series.

Another direct-connected vertical unit shown by this firm is a 250-kw. direct-current generator driven by a vertical compound engine constructed by Meer Brothers of München-Gladbach. This is shown in Fig. 1. The speed is 200 r.p.m., and the dynamo supplies a current of 500 amperes at 500 volts e.m.f. The dynamo is a twelve-pole machine, the poles being made of Siemens-Martin steel, and are 400 mm. (15¾ ins.) wide axially. The field magnet winding consists of 975 turns of copper wire 2.5 mm. (.0985 in.) in diameter. The resistance of the field winding is 59 ohms cold and 66 ohms when hot. The exciting current is, therefore, 7.6 amperes. The outer measurement of the armature of this machine is 1750 mm. (69 ins.) and the axial width is 410 mm. (16.14 ins). The armature core has 224 slots, each 10½ mm. x 27 mm. (.41 x 1 1-16 ins.). The copper conductors are 3 x 7 mm., and there are four in each slot. The resistance of the armature winding cold is 0.112 ohm and hot 0.113 ohm. The armature clearance or air-gap is 6 mm. (.236 in.), the bore of the pole-faces being 1762 mm. in diameter.

Among the other important exhibits of the Rheydt Electrotechnical Works are direct-current and alternating-current motors for both stationary and portable work. One of the most interesting of the latter was mounted on wheels and arranged with its switches, starting resistance and a reel car-

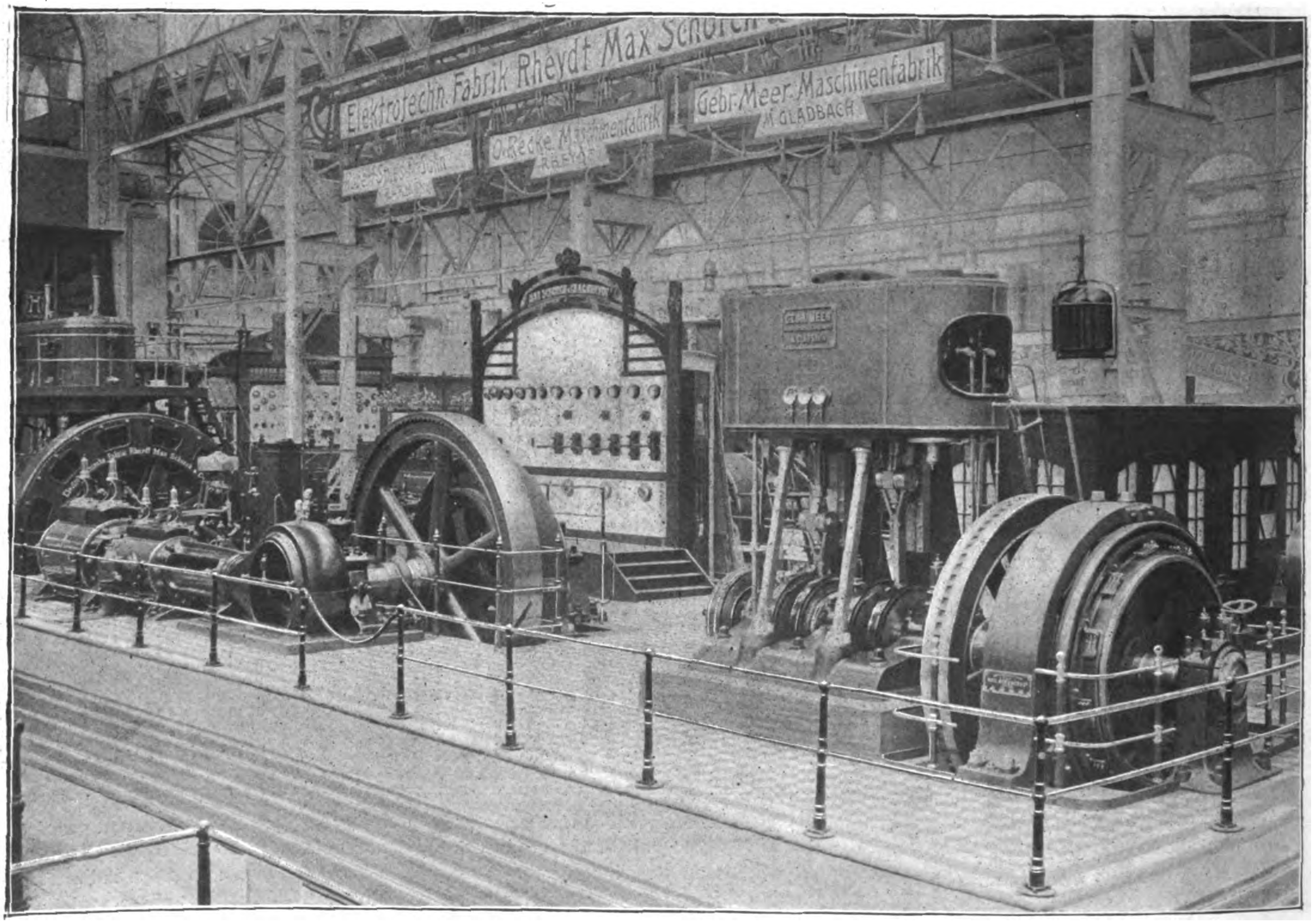

Elektrotechn. Fabrik Rheydt Max Schorch
O. Recke Maschinenfabrik
Gebr. Meer Maschinenfabrik
M. GLADBACH

FIG. 1.—SHOWING TWO OF THE PRINCIPAL ENGINE-GENERATOR SETS AT THE DÜSSELDORF EXPOSITION.

rying the necessary cable mounted on the top of the machine. It is shown by Fig. 4.

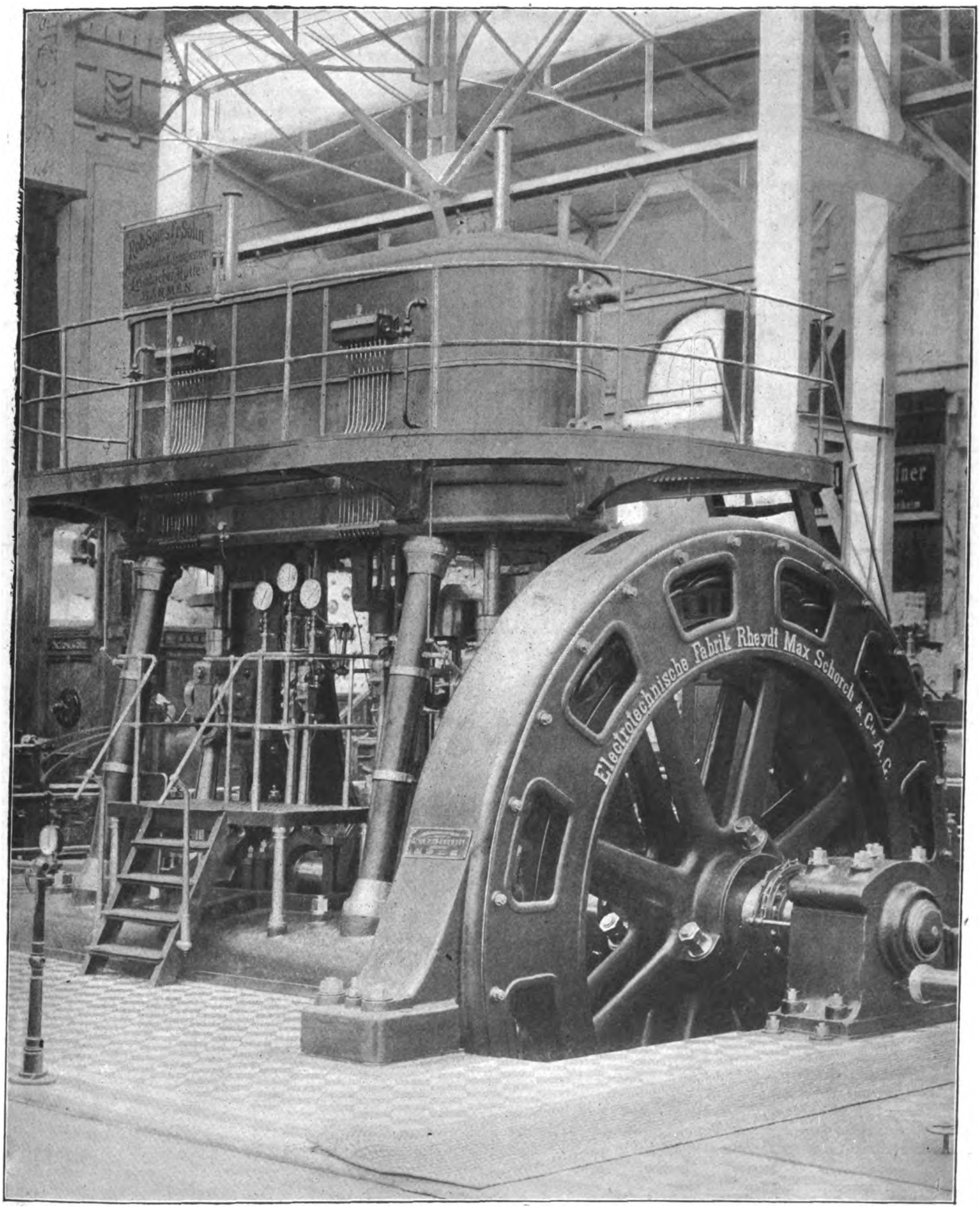


FIG. 2.—5000-VOLT SCHORCH THREE-PHASE GENERATOR DIRECT COUPLED TO A SPIES VERTICAL COMPOUND ENGINE.

An electrically operated pump for use at great depths is of more than passing interest. It was constructed by the same firm, and is designed to raise 4.5 cubic meters of water per minute a height of 60 meters, the motor running at 1600 r.p.m. The pump is used for supplying water for the fountains from the river Rhine.

The generators above mentioned supply current for 5000 incandescent lamps in Industrial Hall, and also for three large exhibit pavilions. For supplying current to the various direct-current motors, a 200-kw. direct-current Schorch dynamo is used. direct-connected to a horizontal compound engine built by O. Recke, of Rheydt. This unit appears at the left of Fig. 1. The engine is a tandem compound, and drives the dynamo at a speed of 140 r.p.m. The dynamo is a 14-pole 500-volt machine, with an armature 2150 mm. (84.65 ins.) in diameter and 410 mm. (16.14 ins.) wide. The field magnet winding consists of 930 turns of copper wire 2.3 mm. (.0905 in.) in diameter, and the complete winding has a resistance of 77 ohms cold and 87 ohms hot.

The armature core has 275 slots, each 10½ mm. x 27 mm., and containing four conductors 3 x 7 mm. (.118 x .275 in.) each. The resistance of the armature winding is .018 ohm cold and 0.0205 ohm hot. The air-gap is 7 mm. (.2756 in.) and the bore of the field pole-faces is 2164 mm. (85.2 ins.) in diameter.

Among the polyphase apparatus exhibited by this firm may be noted also seven transformers varying from 20 to 30 kilowatts each and designed for reducing the 5000-volt three-phase currents of the large generator to 110 volts for lighting and motor work. There are 46 direct-current motors exhibited and 9 polyphase motors, ranging in capacity from ½ to 100 horse-power each.

One of the most interesting exhibits is a large vertical triple-expansion steam engine of 3000 horse-power, direct-connected to an alternating-current generator and a direct-current exciter, the latter dynamo being mounted at the end of the engine shaft outside of the main alternator bearings. This engine was built for the central station at Essen. The diameter of the high-pressure cylinder is 830 millimeters (32.67 in.) and the low-pressure cylinder is 2050 millimeters (80.7 ins.), while the intermediate cylinder measures 1400 millimeters (55.12 ins.) in diameter; the length of stroke is 1200 millimeters (47.24 ins.). The speed of the engine is 94 r.p.m., and the low-pressure cylinder is equipped with cylindrical-valve gear, while the high-pressure and intermediate cylinders are provided with Gutermuth's distributing valve motion.

Among the larger engines shown in Machinery Hall is one of 2000 horse-power, built by the Grevenbroich Machine Works of Grevenbroich (Rheinland). This engine is of the twin tandem compound horizontal type, and has on each side of a high-pressure cylinder 725 mm. (28½ ins.) in diameter and a low-pressure cylinder 1100 mm. (43.3 ins.) in diameter; the stroke common to both is 1300 mm. (51.2 ins.). This engine runs at 72 r.p.m., and is direct-coupled to a three-phase alternating-current generator built by the Helios Electric Company of Ehrenfeld, near Cologne, Germany, which supplied a large proportion of the necessary electric current for the exhibition.

The engine develops 2000 effective horse-power when worked condensing with the cut-off at quarter stroke and with steam pressure of 150 lbs. per sq. in. in the high-pressure steam chests. Siemens-Martin steel is used in the construction of the crank-shaft, and it is bored throughout its entire length; the wrought-iron cranks are shrunk on. The large main pedestals which carry the crankshaft are cast in one piece with the Corliss frames, and the frames have tubular guides carried by the foundation throughout their length. There are four parts to the steps of the main bearing and the crank and cross-head pins are in two parts. All the bearings are adjustable, and the main and crankpin boxes are lined with white metal. The cross-head pin bearings are of bronze and the crankpins are of nickel steel. The cross-head pins are of crucible steel, and the cross-heads are of polished cast-steel and provided with long cast-iron shoes. The piston rods are of Siemens-Martin steel, and are all of the same diameter—160 mm. (6.3 ins.). The pistons are hollow and are built so as to support their own weight. They are secured to the rods by means of cones and nuts, and are made of cast iron. Metallic packing is used on the piston rods.

The oil distribution and devices for catching the waste oil are so arranged that all the lubricating apparatus for moving parts are fixed and may be attended to and replenished at any time while the engine is in motion, as is common practice. Sight-feed drop lubrication is used for all parts not subjected to steam pressure, and Mollerup's oil pumps are used for lubricating the parts under pressure. For the lubrica-

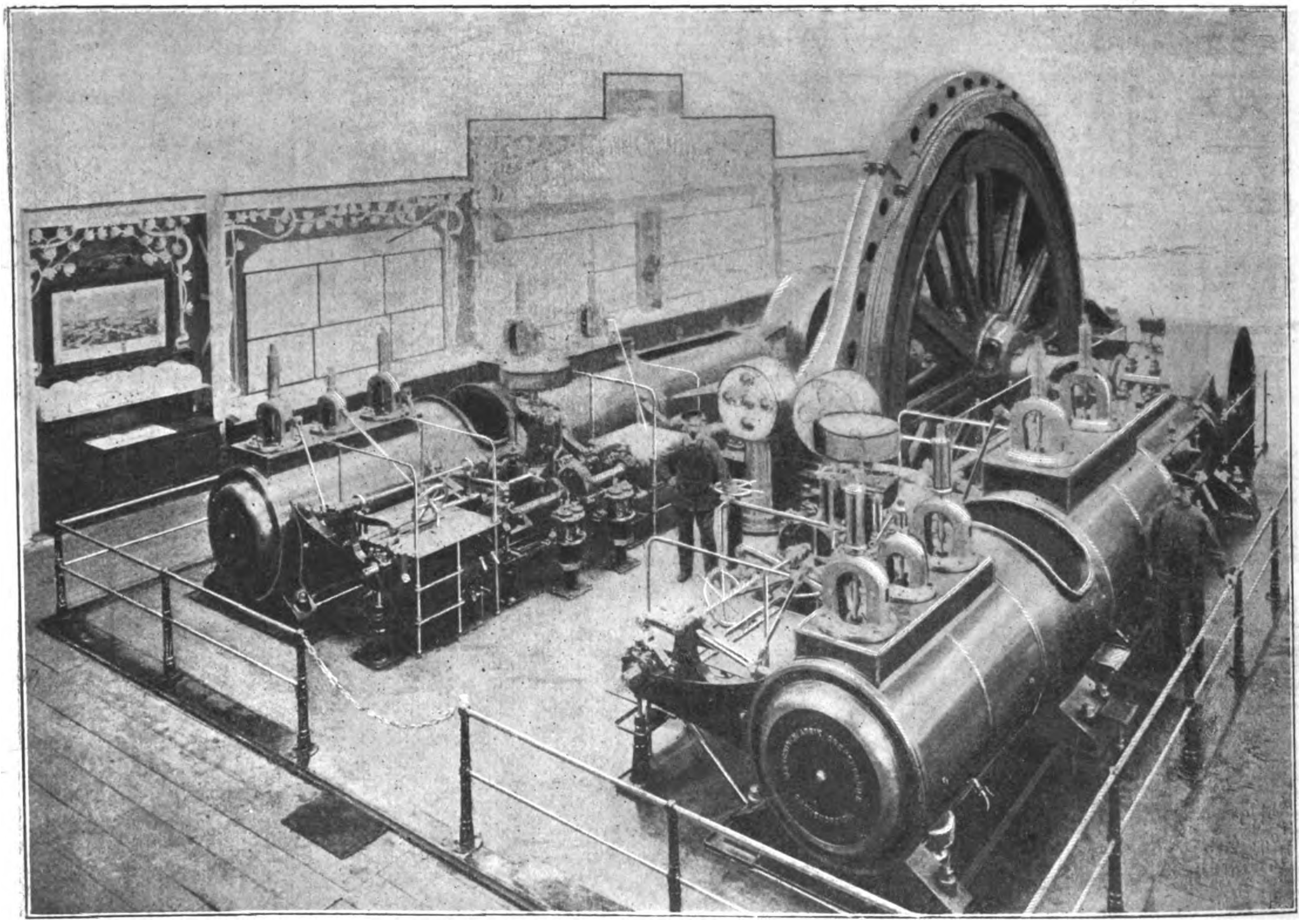


FIG. 3.—2000-H.P. TWIN TANDEM-COMPOUND ENGINE COUPLED DIRECT TO A HELIOS POLYPHASE ALTERNATOR.

tion of the cross-heads, each pin is provided with an oil cup having a metal wiper. The fixed drop feed lubricator is provided with a socket carrying a fine brush, on which the oil from the lubricator drops, and then as the wiper on the cross head pin lubricator comes opposite, the oil is wiped off the brush and carried with the cross-head. This will be recognized as the method used some years ago on American high-speed engines. The guide shoes are provided with oil grooves and equipped with scrapers of copper below, and of felt above, by means of which the oil is very efficiently distributed over the curved surface of their path.

Distance pieces are used to connect the high-pressure cylinders to the low-pressure cylinders and the latter are directly connected to the Corliss frames, and the cylinders have steam jackets, the whole being cast in one piece. Direct live steam is used for heating the high-pressure cylinders and receivers, and working steam through the main stop valves of the engine is used for heating the low-pressure cylinders.

Each side of the engine may be worked independently and the cock levers and stop valve are all accessible from one position.

In all four cylinders the steam distribution is effected by means of double-beat valves, four being used on each cylinder. The admission and exhaust valves on the high-pressure cylinders are worked by positively closing valve-gear, while the valves of the low-pressure cylinders are worked by cams which are adjustable. Bevel gears are used for driving the valve-motion shafts, and the shafts are provided with expansion couplings in order to allow for the longitudinal expansion of the steam cylinders. Above the main pedestal cover there is an oil reservoir from which the oil passes into the bearing proper by means of tubes with an adjustable visible drop feed. The steps of the bearing, as well as the shaft journal, have appropriate oil paths formed in them to insure a proper circulation of the oil, while the oil which flows away from the pedestal is caught in receptacles provided with fine sieves in order to keep out the dust. The oil is pumped from these receptacles back into the oil reservoirs by small oil pumps driven by chain wheels from the valve-motion shafts. The reservoirs are furnished with fine sieves and diaphragms of felt to catch the impurities, and in order that the thick deposits on the bottom may not be allowed to enter the pedestal, the oil is not taken from the deepest point. This arrangement of oil circulation provides very lavish lubrication.

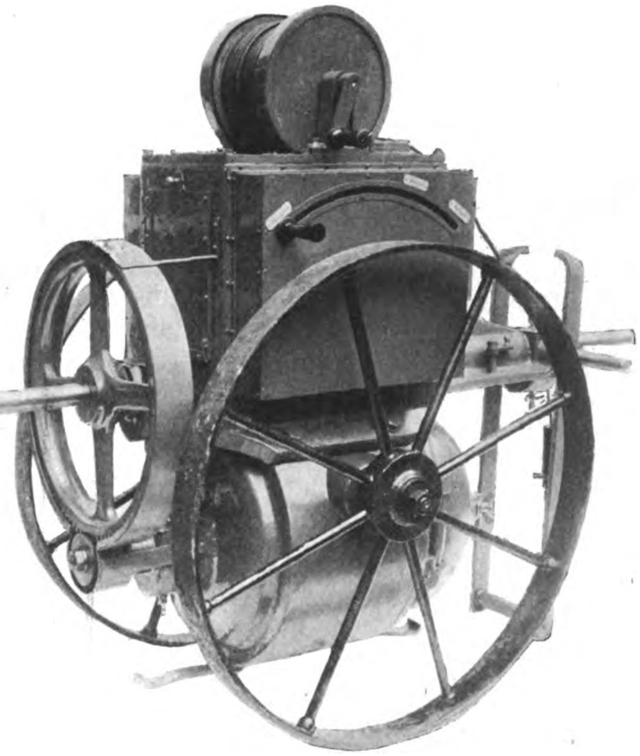


FIG. 4.—PORTABLE ELECTRIC MOTOR, CABLE AND REEL.

The Grevenbroich Machine Works also exhibits in the main steam generating station of the Exposition an interesting type of water-purifying apparatus. It has a duty of 4444 imperial gallons per hour, which is sufficient for half of the boilers exhibited. The water used for purification is taken from the hot well of the condensing plant (injection condensers). The apparatus is constructed in the form of a press, and is horizontal, containing in itself the heater, filter and precipitating apparatus, the three parts being mounted together in one frame in such a manner that a number of heater elements in the form of plates, each having a special inlet for steam and for water, are arranged in sequence adjoining the fixed head. The precipitation tank is next, and the filter elements join directly on to this. These contain a channel through which the filtered water is conducted back through the precipitation chamber and the heater elements to the fixed head again.

In the operation of this apparatus an independent vertical compound steam pump takes the water to be purified from a collecting tank and forces it through the purifier, delivering it first into the heater, whence it passes into the precipitation tank above, where lye is added to it in a definite proportion, according to the quantity and quality of the water. The water along with the precipitated matter then passes out from the precipitation chamber into the adjoining filter chamber, whence it is led into a reservoir from which the feed pumps take water for the boilers. The water is heated by either exhaust or live steam, according to circumstances.

THE NEW DIESEL OIL ENGINE.

In spite of the fact that the late Bryan Donkin set the stamp of his approval on the Diesel engine by translating Mr. Diesel's book, "A Rational Heat Motor," which was published in Berlin in 1893, and by contributing to *The Engineer* of London several articles relating to this engine, the engine, as is well known, has not up to the present achieved commercial success. During the past year, however, great improvements in the way of structural simplification and the modification of the thermodynamic action of the engine have been made, and, according to an article recently published in the paper referred to above, the new type of engine is destined to become a success. The writer of the article mentioned states frankly that an investigation of the new engine in operation has caused a complete reversal of his judgment, which is now as highly favorable as it was formerly adverse. It is stated that the Diesel engine in its latest form is capable of consuming petroleum refuse, so that it can be operated on the rawest and crudest of oils.

Mr. Diesel started out with the idea of producing an engine in which none of the heat supply would be used up by internal molecular work, all of the heat units being spent in doing external mechanical work. Further, thermodynamic study showed him that this was both impracticable and unnecessary to the design of a commercially acceptable engine. His original diagrams resembled more or less closely the one shown by Fig. 2 herewith, in which the line *a b* represents isothermal compression effected by combined mechanical compression and thermal-cooling; *b c* is adiabatic compression; *c d* is isothermal expansion produced by combustion, and *d a* is adiabatic expansion. The stage *a b* was suppressed at an early date in the investigation. The upper part of the diagram near the angle *c* contributed very little to its area in proportion to the cost of construction involved by the use of excessively high pressures, so that this top part was sought to be cut off by a horizontal line, that is, the heat supplied by combustion was allowed to take effect in expansion at approximately constant pressure instead of at constant temperature.

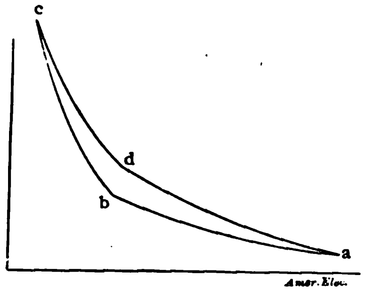


FIG. 2.

Similarly it was later on found economic to cut off the narrow prolongation at corner *a*, for precisely the same reasons as leads to this being done in steam engines, namely, in order to reduce cylinder bulk and cost per horse-power. Figs. 2*a*, 2*b*, and 2*c* are reproductions of three of the very early actual diagrams, while Figs. 3 and 3*a* give samples of diagrams taken from a recently constructed engine. Fig. 4 is a diagram of the air admission, and the exhaust taken with a very weak indicator spring. The first of these—Figs. 2*a*, 2*b*, and 2*c*—are evidence of an engine overburdened by excessive volume, and therefore weight and constructive cost per unit of work done per stroke, and by the need of extra costly strength as against excessive initial pressure.

Mr. Diesel also at the start created prejudice against his engine by speaking of his plan of compressing the air to "incandescence." His phrase was "glühend," or "glowing." The lower limit of this temperature condition- is "roth-glühend," or "red hot"; while the upper limit is "weiss-glühend," or "white hot." This phrase naturally made engineers think of cylinder walls and cover and piston rising towards softening temperatures, and of badly warped valves and seats. No such temperatures, however, really appeared even in the original unreformed diagrams. The temperature reached at the end of the compression is lower than that developed later towards the end of the period of combustion, and this latter is only what occurs inevitably in explosion, oil and gas, engines worked under similar conditions. The temperature after purely adiabatic compression, would, according to theoretic calculation, be about 1,000 degs. Fahr.; but, as the cylinder lining is thoroughly water-jacketed and, therefore, considerable cooling takes place during this compression, the actual temperature must be a good deal below this level.

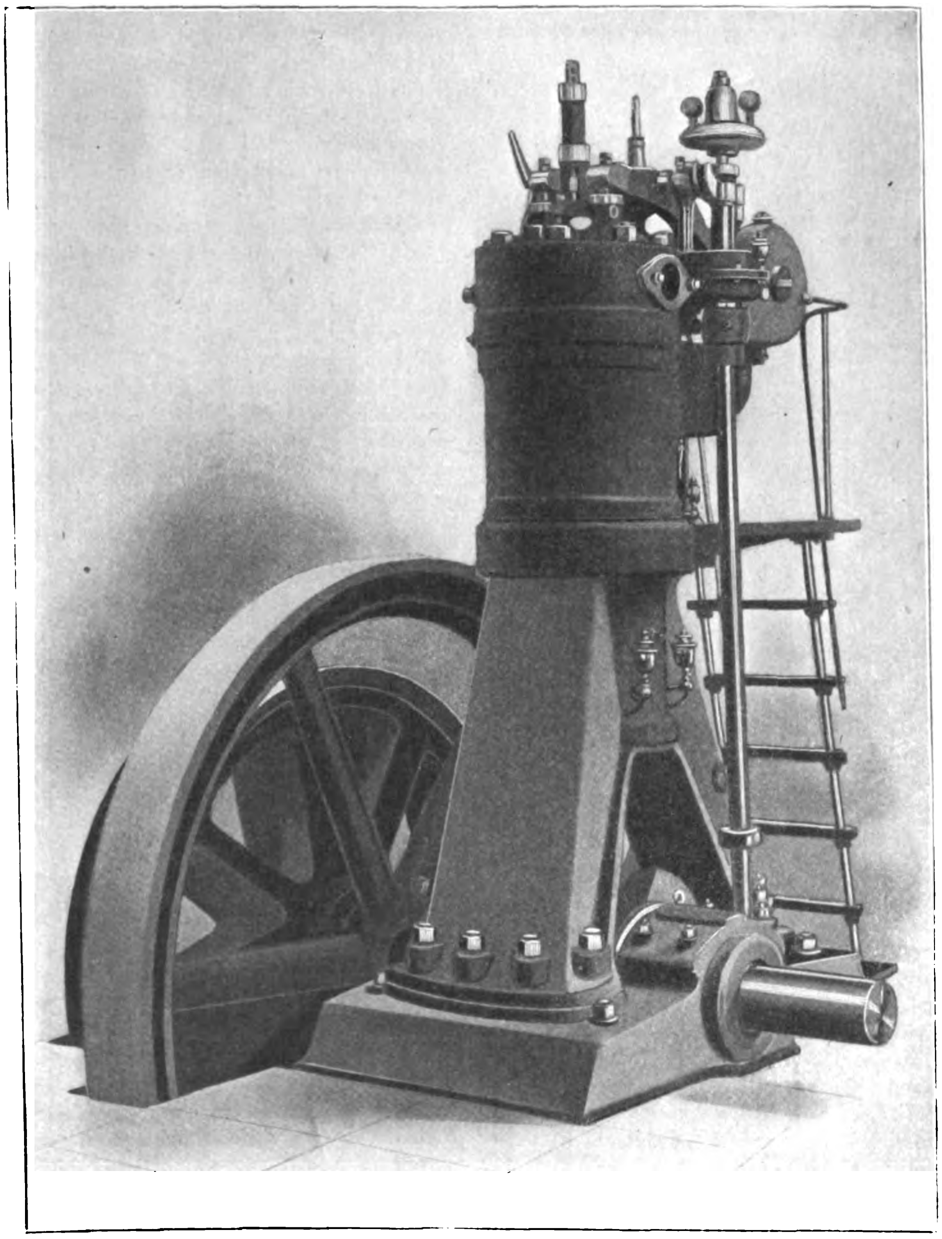


FIG. I.—DIESEL OIL ENGINE.

This water jacketing was not a feature of the original engine, but its application was found to thicken up the diagram to so important an extent that for this and other reasons it has long since been adopted. One effect of the water jacketing is to revert in some degree towards the originally intended shape of the compression curve, that is, to keep the first part of this curve low down, and to make it rise more sharply in its later portion, thus flattening the diagram and raising the mean effective pressure.

There are four leading features of the Diesel that distinguish it from all other oil and gas engines. The first of these is the attainment of the temperature necessary for ignition by mechanical compression alone, so that all injected flame, or incandescent tube, or electric spark, or other extraneous igniting devices, is abolished. The second is the injection of the fuel only after compression has been completed, and only during the first part of the working stroke, the compression in the working cylinder being that of air alone. Thus no explosive mixture exists in the cylinder before the beginning of the working stroke, and no premature ignition is ever possible. The third distinctive feature is that the fuel is injected gradually into the highly-heated air, each drop of the spray burning immediately and quietly, so that no explosion takes place, while the period of injection and the quantity injected are delicately regulated by the governor in accordance with the demand for power. Thus, fourthly, governing is effected within the four-stroke cyclic period of thermodynamic action, and every such period has its working stroke.

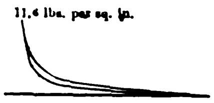


FIG. 2*a*.

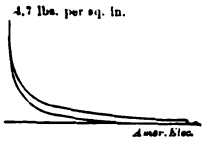


FIG. 2*b*.

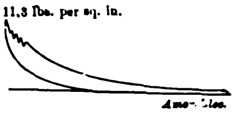


FIG. 2*c*.

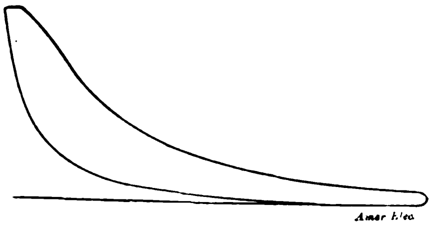


FIG. 3.

The external appearance of a vertical single cylinder engine of the latest type is shown by Fig. 1. Fig. 5 is a vertical cross section, and Fig. 6 a longitudinal cross section. Fig. 7 gives a plan of the engine. Twin-cylinder engines are built up to 200 horse-power, and the Augsburg firm have completed plans for engines up to 1,000 horse-power. The sectional illustrations show the latest construction. The cylinder lining is of dense cast iron. This is set into the outer casing, the spacing between which and the lining forms the water jacket of the walls, and this casing is cast in one with

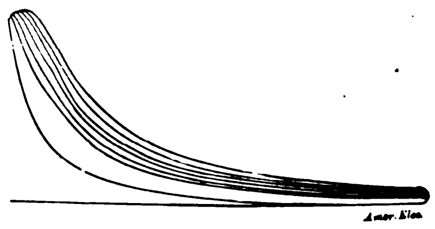


FIG. 3*a*.

the two legs of the standard frame. This is heavily bolted to a stiff bed-plate carrying the two main crank shaft bearings. The cylinder is open at its lower end, and the piston is an open trunk. For 30 normal brake power the diameter is 300 mm., or about 12 in., with 460 mm. or 18 in. stroke. The length of the trunk piston is about 2 1-3 times its diameter. The piston packing consists of seven plain rings. The connecting-rod pin, which has very ample bearing surface, is situated a little lower than the mid-depth of the piston.

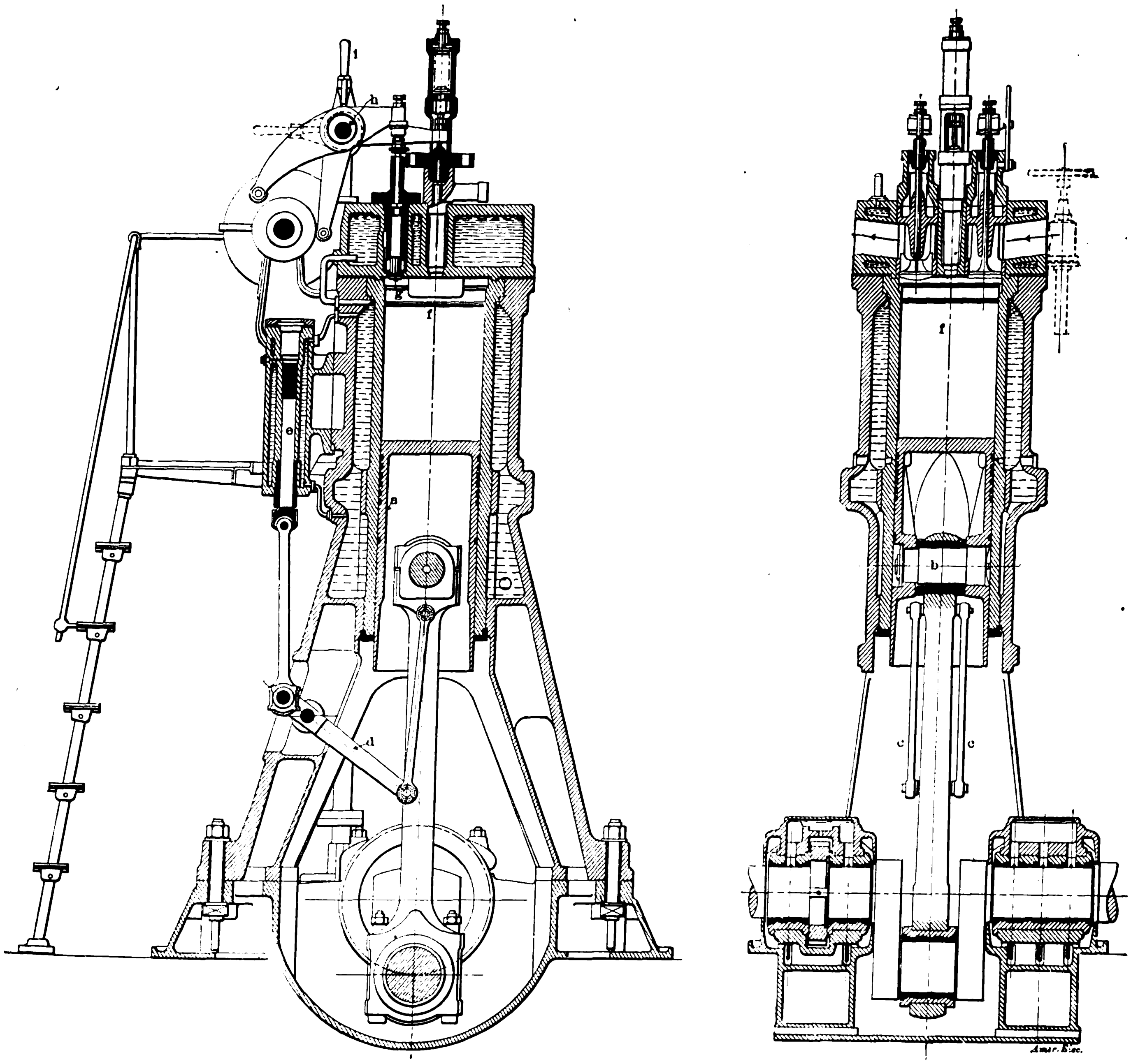


FIG. 5.—SECTIONAL VIEWS OF DIESEL OIL ENGINE.—FIG. 6.

The cylinder cover is very deep, and is strongly bolted to the cylinder. In it are cast four valve-boxes, and the remainder of its interior space forms a jacket through which the cooling water is circulated. The two large mushroom valves seen in Fig. 6 are for the air admission and for the exhaust. These valves and their passages are of very large area, so that the diagrams show practically no suction vacuum and no back pressure during exhaust, as shown in diagram Fig. 4. These two valves are opened downwards against spring pressure by cranked levers and roller cams. When not opened, they are held against their seats by the pressure in the cylinder as well as by their springs. The central plug valve seen in Figs. 5 and 6 is for the admission of the oil fuel. This valve is lifted to open it by a similar lever and cam. Just above the conical seat of this valve the valve-box walls are slotted longitudinally with a number of narrow grooves about 1 mm. wide and of tapering depth. Above these tapered slots lie three small brass discs, spaced vertically about ¼ in. apart, and each pierced by twenty holes of 1 mm., or 1-25 in. diameter. These perforated plates and the tapered slots below them constitute together the whole spraying apparatus, and it is found that no clogging of the apertures takes place. Formerly when a wire gauze sprayer was used such clogging occasionally gave some trouble. Below the conical valve seat the passage for the oil is a single bore 1-5 in. diameter. This debouches upon a small hard steel plate pierced with one conical hole ⅛ in. diameter at top, and about ½ in. or ⅝ in. diameter at the lower surface. This discharges the oil spray in an expanding conical jet into the middle of the air heated by compression.

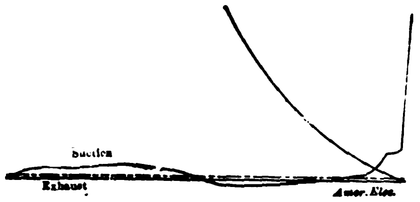


FIG. 4.

The oil is blown through this sprayer and into the cylinder by a small charge of air compressed to about 90 lbs. to 100 lbs. per square inch above the final pressure of the compression in the working cylinder. This small quantity of air is compressed to this higher pressure by the small compresser pump seen to the left hand of Fig. 5, which is driven by a side lever and link from the small end of the connecting rod. The pump draws, not directly from the outside atmosphere, but from the main cylinder during the compression stroke. Thus the working cylinder and the small pump form together a two-stage compressor. Formerly the air pump drew straight from the atmosphere; but the improved arrangement here described has enabled the pump to be reduced to one-fourteenth of its previous volume, besides introducing the well-known advantages of two-stage compression. This pump is water jacketed, both round its walls and in its top cover. The cooling water passes first through the pump jackets, then through the cylinder wall jacket, and finally through the cylinder cover. It then flows to a small belt-driven centrifugal pump, which lifts it to an overhead cooling tank, whence, after cooling, it flows by gravity once more through the jackets.

The work done in the small compressor was originally, before the above two-stage arrangement was adopted, about 4 per cent. of that done in the main cylinder. We have not got measurements of the actual amount since the introduction of the two-stage compression; its estimated value is now only about one-half per cent. of the whole. The work so done is not lost; only a portion of it is spent on the friction of the pump and valve passages. The rest is redelivered to the main piston during the working stroke.

This pump delivers the air, not direct to the valve-box for the oil admission, but into a pair of cylindrical high-pressure air reservoirs. In a 30-h.p. engine, one of these is of about 13½ ins. internal diameter by 5½ ft. long, while the other is about 6 ins. internal diameter by 2½ ft. long. In the smaller a steady pressure, some 6 to 10 atmospheres above the maximum cylinder pressure, is maintained, and during working this is kept in open connection with the above valve-box. The larger vessel serves as an overflow from the smaller one, when the pressure in the latter rises above the loading of a valve inserted between them. To avoid possibility of excess of pressure in the working cylinder at the end of the compression stroke above that desired, there is a similar suitably spring-loaded overflow valve from the top of this cylinder to the larger air-pressure reservoir.

The larger air vessel contains a reserve of compressed-air power for starting the engine. This is done by help of the fourth valve in the cover. This valve is kept shut by spring force, as are the other three, and, like them also, is opened by a lever and cam. Its lever, however, is lifted out of reach of the cam-tooth during normal working, and is only let down into gear with its cam when the engine has to be started. This is very simply done by throwing over a hand lever, which turns a short spindle carrying the eccentric fulcrum of the operating valve lever. To start the engine this lever is let down on its cam, and the crank shaft pulled over to the top dead-center. The cam now opens the starting valve, admitting the high-pressure air from the reservoir onto the top of the working piston. Under this heavy pressure the engine starts away at once very easily.

This same starting valve is, in the later designs of the engine, made to serve during ordinary working as the suction valve of the air-compressor pump.

One of the very remarkable things about this engine is the surprising ease, promptitude and quietness with which this starting is accomplished. No preparation of any kind whatever is required. The engine is taken exactly as it may have been standing idle for one or several hours, or days, or weeks. The pulling of the crank to the top dead-point, the pulling over of a small hand lever, and the opening of a small screw-down air valve, are all that have to be done. After about four or six revolutions the starting lever is again thrown back, and the engine thereafter looks after itself. In large engines, this starting lever and cam are thrown automatically out of gear by the governor as soon as normal speed is reached; but hand gear is preferable for the smaller sizes, and it is always available in the larger.

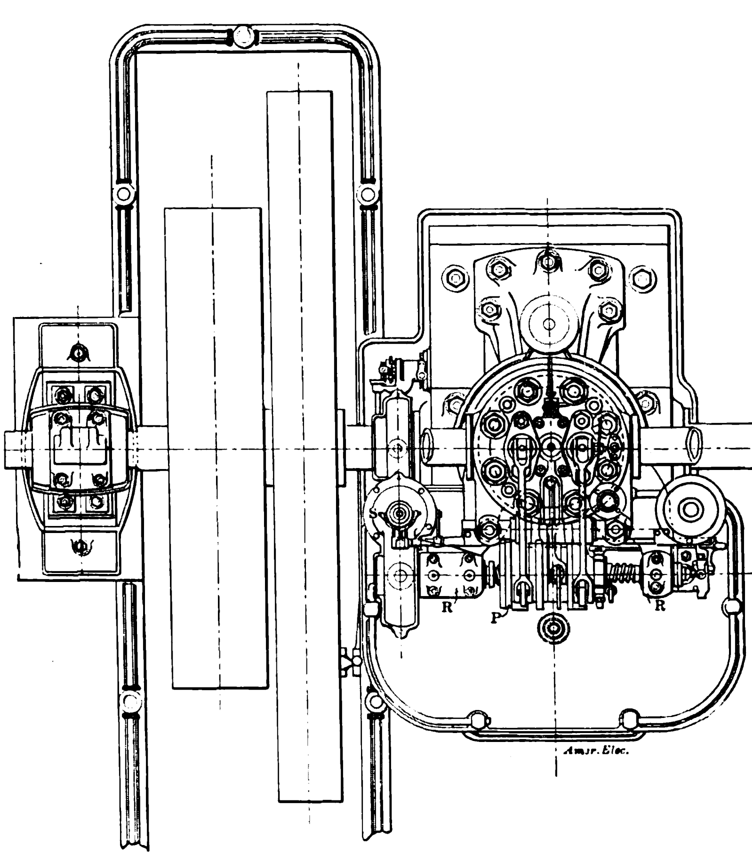


FIG. 7.—PLAN VIEW OF DIESEL OIL ENGINE.

The air reservoirs are made of Mannesman steel tube. In use they have to stand from 40 to 60 atmospheres pressure, or from 570 lbs. to 850 lbs. per square inch. The screw-down valves are well ground, and hold this pressure indefinitely without leakage. The practice in erecting a new engine is to pump up these reservoirs in the Augsburg works, and to send them thus charged to the place of erection. Thus an engine erected this year at Harrogate had the air reservoirs initially charged at Augsburg, and sent over there, where they lay for over six weeks without losing pressure before they were used for starting the engine. They may also be initially charged with air by a hand pump, or by help of bottles sent from any neighboring gas-compressing works, such bottles being now easily procurable in all towns, or by any ordinary chemical admixture for producing carbonic acid or any other gas under pressure. Any gas, whether containing free oxygen or not, serves equally well, as the contents of the reservoirs are not used for combustion.

For the illustrations herewith, as well as most of the data contained in this article, we are indebted to *The Engineer*, London.

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Twin Conductors for Service Wires.—The query, "Are twin conductors desirable for service wires?" elicited at the Cincinnati Convention several opinions. Mr. Edward Slade said he found twin cable expensive, but invaluable for service wires. Mr. W. E. Holmes, of Newton, Mass., was of the opinion that twin conductors are not desirable for service wires. He put in for secondary house service wires an iron pipe running from below in the street through the cellar wall, into which were drawn twin rubber-covered solid conductors with heavy outside braid. One of the conductors became grounded in the pipe, necessitating the withdrawal of the twin, and it was not found feasible to return the same when the break was remade and insulated, owing to the increase of size at the joint. He also used twin lead-covered cable built for 3000 volts and used on 2200. This was installed in an iron tube, but broke down after one year's service. In his opinion it is far better to use single conductors. Captain William Brophy said that the great advantage of the use of twin conductors is the reduction of fire hazard incident thereto, but the insulation between the wires should be much lower than the insulation between the same and the pipe in which they are carried.

Niagara Falls Meeting of the American Electrochemical Society.

The second general convention of the American Electrochemical Society, held September 15 to 18 at Niagara Falls, was a conspicuous success in every respect. The only flaw in the entire proceedings was the refusal of several of the electrochemical works to allow inspection of their plants by the delegates. This privilege was granted, however, by the Carborundum Company, International Acheson Graphite Company, Electrical Lead Reduction Company, and Atmospheric Products Company.

Mr. Francis A. J. Fitzgerald presented the first paper of the meeting, the title being "Notes on Testing Carbon Electrodes." It was pointed out that the efficiency of an electrode depends largely on its density, and the paper deals with methods for the determination of density. Two determinations are made—first, of the density of the carbon of which the electrode is made, and, second, the apparent density or the ratio of the weight to the volume of the electrode as a whole. The difference of these quantities divided by the first-mentioned expresses the porosity. The paper gives the methods of determination in minute detail. In the case of a specimen, the real density was found to be 2.19, the apparent density 1.63, and the porosity 0.26. In certain electrolytic processes the presence in an electrode of amorphous carbon is undesirable, owing to the accompanying disintegration, and the paper describes a method of testing to determine if they are entirely composed of graphite.

In a paper, entitled "Cathodic Reduction," Mr. Alfred T. Weightman gave the results of experiments with sulphide electrodes, which showed that Thomson's rule does not apply, at least when expressed in its simple form. The two divergences are with respect to the voltage of reduction and the amount of hydrogen released. It was shown that much less hydrogen is released than the rule calls for, and this fact is of advantage in commercial working. The higher voltage accords with the views of Caspari and others, that the voltage necessary to liberate hydrogen is not a constant, as implied by Thomson's rule, but is dependent on the metal which constitutes the cathode. Mr. Weightman adds that in addition there is probably also a variation in voltage for H_2S with different metals.

A lengthy discussion followed the reading of the paper, in which Messrs. Reid, Keith, Smith, Rodman, Haber, Smith, Blackmore, Hering, Hutton and Sperry participated. Mr. Reed did not consider Caspari's theory necessary to explain the results arrived at, but Professor Haber and others took the opposite view—namely, that Caspari's theory of over-voltage was correct and applied to the experiments in question.

A paper by President J. W. Richards, entitled "Efficiency of Electric Furnace Operations," discussed a large number of operations. From the data presented, it appears there is an unexpected uniformity in the efficiency of different processes where the heat is employed, not only in melting the material but also in chemical action. In this case the efficiency is generally 50 to 60 per cent. In processes where there is simply a heating action without chemical action, the efficiency is higher, approximating 70 to 75 per cent.

In the ensuing discussion, Mr. Hering said that determination of the efficiency involves knowledge of the actual energy necessary to a given process, but that in many cases this is not exactly known; consequently until this theoretical quantity is fixed, efficiencies must be accepted with caution. In reply to a question by Mr. Brindley as to the reduction of radiation loss by double walls, Professor Richards said that the important factor is whether the operation is conducted slowly or quickly.

The final paper of Monday's session was "Differences of Potential Between Metallic Sodium and Solutions of Cadmium Iodide in Various Solutions," by Professor Louis Kahlenberg. The greatest potential difference was measured between cadmium and cadmium iodide in a large number of various solutions, the other electrode in each case being Helmholtz's normal electrode. The general result was that the potential difference between a metal and a solution is primarily determined by the chemical affinity. With solvents of similar chemical character there is little variation in the potential difference.

On Tuesday morning a paper on "Developments in Electrometallurgy of Iron and Steel," in the absence of the author, Mr. Marcus Ruthenberg, was read by Professor Hart. A method outlined consists in principle in using an electric furnace combined with the action of a magnetic field. The melting zone of the electric furnace is a magnetic field. The ore being magnetic, the magnetic field seizes and holds the grains of the magnetite, and the polar projections being at the same time the electrodes of the smelting circuit, the magnetic bridge thus formed by the ore forms a high resistance in the smelting circuit. The heat of the smelting circuit is engendered within the bridge of ore itself. The electrodes are water-cooled. When the ore is melted it loses its magnetism and drops out of the magnetic zone, new material being substituted. In the animated discussion which followed the general opinion seemed to be that there is at present no probability of the electric furnace superseding the blast furnace in the reduction of iron ores; that the ordinary iron smelting furnace of to-day is a very efficient piece of apparatus; and that magnetic concentration of ores is only of use in the case of low-grade ores.

In a paper by Dr. Eugene A. Byrnes, entitled "Voltaic Cells with Fused Electrolytes," the results are given of a great many measurements of the e.m.f. of cells, in which the electrolyte was fused sodium hydroxide. The cell was divided into two parts by a porous diaphragm. The one electrolyte was graphite, and for the other many various substances were used. Different depolarizers were used. The results of the measurements are in several points in good agreement with results obtained by Liebenow and Strasser. In the discussion, Mr. Reed claimed that the e.m.f. of such cells is nearly wholly thermoelectric, but this was contested by Mr. Byrnes, who said that the thermo e.m.f. is only a factor and not the principal one.

A paper, entitled "The Fusion of Quartz in the Electric Furnace," by Professor R. S. Hutton, of Owens College, Manchester, described a process for making quartz fibres and small tubes for scientific purposes. An arc furnace is used, and the quartz fused in a mould of graphite. At first there were difficulties, owing to air bubbles, but these have been overcome. Professor Hutton considers there is a commercial future for the process.

In a paper, entitled "Thermoelectric Theory of Concentration Cells," Professor H. S. Carhart extended his discussion of this subject, which was presented at the Philadelphia meeting. In Nernst's formula, the e.m.f. of a concentration cell is proportional to the absolute temperature, which suggests a thermal origin. The same conclusion is reached from Helmholtz's formula for the e.m.f. of a voltaic cell; for a concentration cell the first term of this formula is zero, corresponding to the formation heat of the chemical processes, and the e.m.f. is directly equal to the absolute e.m.f. multiplied by the temperature coefficient of the e.m.f. A concentration cell is a device for converting heat into electrical energy. Curves were exhibited, showing the relation between thermo e.m.f. and concentrations, and it was shown how the law of the inverse of the thermo e.m.f. with the concentration explains several obscurities relating to the Daniell cell.

The paper was discussed at length, and doubt was expressed whether the particular nickel cell is really a true concentration cell; Professor Carhart did not deny that there may be chemical action in it.

Mr. Carl Hering, in a paper entitled "An Apparent Electrochemical Paradox," described a curious experiment which he and Mr. Charles J. Reed made some years ago, in which water was decomposed in visible quantities at voltages far below the theoretical (about 1.45), even as low as about 0.3 volt. The experiment consisted in electrolyzing acidulated water in a strong N-shaped glass tube, which was sealed at both ends, and provided with a bend containing mercury, which enabled the mechanical pressures to be read off. The results were shown in a curve. The pressures reached about 23 atmospheres when the tube exploded. The voltage at the terminals when a constant current passed diminished rapidly and very decidedly to about 0.3 volt, at about 16 atmospheres, and then remained practically constant. Allowing for the loss due to resistance, the actual voltage of decomposition was even much lower—nearly zero. There was visible gasing during the whole test, showing that water was really being decomposed; the increasing pressures also showed this. A possible explanation was suggested, based on the assumption that some of the gases probably passed mechanically to the opposite electrode, which they could easily do in suspension, as the electrodes were very close together. These were consumed as depolarizers, so that only a fraction of the theoretical amount of gas was really liberated. This depolarization lowered the voltage. A calculation based on this reduced amount of gas which was actually liberated, on the actual current which passed, and on the energy which must be accounted for to conform with theory, would also show that the required voltage need be only very low; the lower the greater amount of depolarization. The paper concluded with a suggestion of an experiment in which water is electrolyzed in a strong, sealed vessel, which is completely filled so as to leave no room for the gases. Some curious results may then be expected.

The first paper read on Wednesday was entitled "Electrochemistry at the World's Fair, St. Louis," and was read by the author, Professor W. E. Goldsborough. The paper gave an outline of the plans for the exhibition, which it is intended shall outrank all international exhibitions thus far held. In the electrical department a strong attempt will be made to show processes rather than manufactured articles; 2000 horse-power will be available in the Electricity Building, to give the exhibitors an opportunity to show their processes in operation. There will be shops in which electric motors, incandescent lamps, storage batteries, etc., are being made, so that the different steps of the manufacture can be clearly seen. In the electrochemical department, the aim will be to make the people of the country at large familiar with the electrochemical applications. There may be electrochemical exhibits in various other portions of the exposition, but in the Electricity Building electrochemical processes will be shown in operation, the exhibitor, of course, not being required to show anything which it would be expedient to keep from the public. He may exhibit a model plant which embodies only the fundamental and essential points of the process, while it may differ in many details from the actual process as worked on an industrial scale, thus not revealing any trade secrets. The speaker concluded by extending to the American Electrochemical Society an invitation from the Business Men's League, of St. Louis, to hold a meeting there in 1904.

A resolution was then passed expressing the good-will of the society toward the Exposition and offering its co-operation in the organization of a comprehensive exhibit in the group of electrochemistry.

A paper was then read by Dr. H. T. Barnes, of McGill University, on "The Theory and Practice of Continuous Flow Calorimetry." The author has in recent years been a very active worker in determining some of the fundamental quantities of the science of physics, and his paper was interesting through showing the high accuracy which can be obtained in modern methods for this purpose. In principle, the method of continuous flow calorimetry consists in having a flow of liquid continuously heated by an electric current in a fine-flow tube. When the conditions have become stationary, the temperature of the inflow and outflow and e.m.f. and current are measured. The different sources of error were discussed in detail, and methods were described for eliminating them. A fact brought out in the discussion was that the investigations of Dr. Barnes have given results which are in almost exact agreement with Carhart's determinations of the e.m.f. of the Clark cell.

Mr. Woolsey McA. Johnson followed with a paper on "The Electrolytic Dissolution of Soluble Metallic Anodes," which dealt mainly with the problem of the dissolution of anodes consisting of alloys. Every metal has a certain electrolytic "tension" (or potential difference against the electrolyte), depending on its physical condition, its temperature and the electrolyte. This tension is greatly affected by alloying the metal with other metals, and the conductivity is greatly decreased. In a composite metallic anode are segregated various voltages, corresponding to the different metals. The author gave some applications of these principles, and discussed especially the prenomenon of slimeing in electro-refining processes. For many purposes he recommends pyrometallurgical treatment, before the electrolytic process is undertaken.

Mr. Arvid Reuterdahl read a lengthy paper on "The Electronic Hypothesis and its Application." In the first part he gave a summary of the modern hypothesis of electrons or negatively charged corpuscles, smaller than atoms, and of the experimental facts concerning radiant matter, upon which this hypothesis is based. In the second part he attacked vigorously some fundamental conceptions and laws of physics. He considered that the law of gravitation is too one-sided, because it considers only attraction, but that all difficulties disappear if the electron law of inverse squares is substituted for the law of gravitation. In the discussion which followed, Professor Carhart strongly criticized some of the author's criticisms.

"Storage Battery Invention" was the title of a paper by Mr. Hugh Rodman, which was written from a thoroughly practical point of view. From the requirements of practice, Mr. Rodman considered that the list of available anodes and electrolytes is limited to lead in sulphuric acid and nickel in an alkali hydroxide. This does not mean, however, that the active material must necessarily contain nickel or lead, but simply that the grid must be one or the other of these metals in its appropriate solution cell. He considered the Edison nickel-iron cell as the most promising member of new types of storage battery, and compared it with the lead cell with respect to grid, active material and electrolyte. Concerning this last point he said that while the possibility of using a small amount of electrolyte is one of the important factors in making the alkali battery light and small, this very advantage adds greatly to an already serious trouble—that of refilling. As to the question of electrolyte mass, he stated that in the alkali battery a serious trouble is multiplied by a factor of three or four, and then the mass is halved by way of getting around it. Concerning adaptability to different uses, he believed that for central station work the position of the lead cell seems secure. For lighter service, particularly for electric wagons, where watt efficiency and cost are to some extent subordinate to convenience, the choice will depend largely upon capacity and reliability. Exact data are wanting for the alkali cell. For the lead cell he considered that a four or five-ton truck, running 20 miles a day for 300 days in a year, requires new positive plates once in a year, or once in two years, according to whether pasted plates or plates of the Planté type are used, the choice of one or the other being determined by the character of service and length of run desired. Cabs and lighter wagons have about the same life, with a capacity of 40 to 100 miles on one charge. Work done under these conditions has shown that the electric wagon gives better city service than can be gotten from gas or steam or horse. A better battery, either an improvement on the old or a better new one, would control practically all city traffic not on rails.

In the afternoon Dr. F. Haber, professor at the Technical High School of Karlsruhe, Germany, read a paper on "The Phenomenon of the Formation of Metallic Dust from Cathodes." Dr. Haber has studied this peculiar phenomenon for several years, and showed two experiments, in both of which an iron nail was the anode in a 20 per cent solution of caustic alkali, while the cathode was a strip of lead in the one case, and one of tin in the other. By using a current of 20 storage batteries, a black cloud goes off from the cathode and is distributed throughout the solution, so that it finally becomes inky. The cloud consists of fine suspended particles of dust of the material of the cathode. This phenomenon appears singular at first glance, because it is generally the anode and not the cathode which is attacked in electrolysis. The explanation of the phenomenon is as follows: The cation of the electrolyte forms an alloy with the metal of the cathode, and if the current density is high enough the alloy formed contains a relatively high percentage of the alkali metal; such an alloy, however, cannot exist in contact with a caustic alkali solution, because it is at once attacked chemically. When such an alloy is prepared by a purely chemical method and placed in a caustic alkali solution, the same formation of dust occurs at once, and the phenomenon has exactly the same appearance as in the experiments where the dust goes off from the cathode. Hence the formation of an alloy on the surface of the cathode is the primary electrochemical action, while the formation of the dust is secondary and purely chemical. When the electrolyte is an acid, the cathode also is sometimes attacked, although the phenomenon is here much less visible; the author believes that in this case a hydrogen alloy is formed.

In the discussion which followed, Professor Carhart related an interesting method by which he obtained a very firm and closely adhering deposit of platinum black on platinum. He decomposed zinc sulphate with a small current (0.1 ampere) and 50 sq. cm. surface of the platinum cathode for five or six hours; afterwards the circuit was broken and the platinum cathode was left in the solution. After several hours it was found that the cathode was covered with platinum black; the explanation is that primarily a zinc platinum alloy had been formed, but this cannot exist in the solution which contains free acid and disintegrates, leaving the platinum surface coated with platinum black.

"Certain Electrical Units" was the title of a paper read by Mr. Alfred H. Cowles, of Cleveland, Ohio, the well-known pioneer of electrochemical industries. He pointed out that 500 amperes in one day will decompose practically a pound molecule of any univalent compound; he suggests to use this as a unit and to call it the pound Col. While this relation is only approximately correct, the following is said to hold true with great exactness—namely, that 100 amperes for one day will liberate one cubic meter of hydrogen. On account of the great exactness, Mr. Cowles believes that this relation is not accidental, but represents a law of nature. He therefore proposes to use it as a fundamental unit of electrical quantity, and to make it the basis of a complete new system of units. He suggests this in order to co-ordinate mass quantity with electricity quantity and for use in tracing energy in its transformations accompanying chemical reactions. He stated that he has not yet completely solved the problem and found all connecting links which are required, but he believes this can be done.

In the discussion, Messrs. Whitney, Hering, Bancroft, Keith, Reed and Richards participated, most of whom considered the particular relation described to be merely accidental.

"A Closed and Continuous Working Electric Furnace," was the title of the last paper of the afternoon session, the author being Mr. Edward R. Taylor, of Pen Yan, N. Y. He described some recent advances made in the design of his carbon bisulphide furnace, which has been described in detail in these pages. In the older form of his furnace the life of the electrodes was prolonged by regularly feeding upon them at their ends, by gravity, broken conductive material. In his new furnace he goes a step further, and has practically a self-renewing and continuously reproducing electrode in a closed furnace, the broken and moving portions in their continual descent themselves constituting the electrodes. New material constantly descends and takes the place of that exhausted at the ends or points of wear. He showed, in illustrations, some special devices to insure that nothing shall interfere with the regular descent of the furnace charge and the regular continuity of the work.

The first paper read on Thursday was on "Pumps and Other Accessories in Electrochemical Processes," the author being Mr. David H. Browne, of Cleveland, Ohio. In his absence, the paper was read by Mr. Woolsey McA. Johnson. The author described in detail the great mechanical difficulties which he had encountered, and the experience which he had collected, in overcoming the difficulties of handling a hot concentrated solution of chloride of copper and nickel, with many impurities. He described in detail the mechanical problems, in devising lifts for this purpose. As the paper relates mainly to mechanical details, it cannot be briefly abstracted.

A paper by Professor J. W. Langley, entitled "Electrochemical Polarization," was then read, in the absence of the author by Mr. Henry N. Potter. In this paper the author criticized a definition of polarization offered by Mr. C. J. Reed in a paper read some years ago before the Franklin Institute. The parts of Mr. Reed's definition to which exception was taken were that exhaustion of the chemical agents in the neighborhood of the electrodes is a factor, and that polarization is progressive. Among the factors that have been put forward as components of polarization are the counter e.m.f. of the gases formed at the electrode, the resistance of the gas envelope, chemical changes and changes in temperature. Professor Langley claims that polarization *per se* is not progressive, that ohmic resistance forms no part, and he excludes heating effect entirely. His conclusion is that polarization is due to chemical changes and is not in any manner related to ohmic resistance. Mr. Carl Hering, in behalf of Mr. Reed, who was not present, stated that in his opinion Professor Langley had misunderstood the definition of Mr. Reed. Mr. Cowles considered that there was no contradiction in the two views with respect to the final state of polarization, the difference of opinion referring to the actions leading to this final state. Mr. Potter criticized the experimental proof of Professor Langley, owing to the existence of an indefinite time element, which introduced a doubt with respect to the experimental results. He remarked that there are two kinds of definition, one of pedagogic value using general terms, and another expressing closely all the facts; it was, therefore, natural that differences of opinion should exist between those holding to one or other form of definition. Professor Richards said that the view of Professor Langley amounted to a statement that polarization is identical with counter e.m.f.; he considered, however, that one factor of polarization is the resistance of gas at the electrode.

In the absence of the author, Mr. Carl Hering read a paper by Mr. C. J. Reed, entitled "Some Phenomena of Electrolytic Reduction." The paper was in effect an attack on the dissociation theory, and dealt principally with the details of an experiment, the results of which were held to contradict that theory. The essential part of the experimental arrangement was somewhat as follows: A receptacle was divided by two porous diaphragms into three compartments. One of the outer chambers contained a copper electrode in copper sulphate, and the others sulphuric acid. Mr. Reed held that, according to the dissociation theory, during electrolysis both the volume and weight of the contents of the middle compartment should decrease, wheras the experiment showed an increase in both of these. Other divergences from the theory were noted as the result of the experiment, one being that the migration constant is not a constant but dependent on the nature of the electrolyte and on the action at the electrodes. In the discussion, Mr. Woolsey McA. Johnson pointed out that the factors of voltage and rise in temperature should not have been neglected in the experiment. Mr. Hering said that a water bath had been used, but it was pointed out that difference of temperature might yet have existed in the electrolyte. Mr. Henry Noel Potter said that an attack on the dissociation theory could not be conclusive unless it also took into account the support which that theory received from non-electrical facts; for example, the changes in the boiling and freezing point caused by the presence of salts. Mr. Hering said that Mr. Reed's experiments seemed to him to be a mere determination of the migration velocities, and that his results merely differed from those of other experimenters; he also called attention to the fact that the nature of the diaphragm would make a difference. Moreover, the dissociation theory should not be condemned merely because the determination of the migration velocities did not coincide with those of other experimenters. Mr. Potter thought that the apparatus of Mr. Reed was of such a kind as to introduce errors; for example, heat effects could give rise to the difference of volume observed. Mr. Hering also pointed out the probable seat of another error, due to difference of hydraulic pressure. Mr. Potter described an experiment with the Caldwell interrupter, in which the level rose independently of electrolytic action and of the direction of the current; this phenomenon enabled him to make a Barker's mill of this type of interrupter.

Professor Richards considered that the use of the name "dissociation" was unfortunate, for the reason that it caused the student to connect dissociation with chemical disruption. He gave a mechanical analogy to illustrate the difference between purely chemical bond, and the bond existing in a dissociated compound according to the dissociation theory. The former was likened to a bond tying the atoms together, and the latter to the attraction between magnets, which may be strong, but is less rigid. Mr. Potter stated that there is a real physical difference between solutions with and without dissociation, which can be detected by optical means. Professor Richards said sight should not be lost of the fact that dissociation is not decomposition and does not call for energy, the relations of the energy being changed but the quantity remaining unaltered.

The New Westinghouse Steam Turbine.

The West Penn. Railways and Lighting Company, which will shortly operate a very extensive system of electric railways in western Pennsylvania, has under construction a new power station at New Haven, on the east bank of the Monongahela River, in which will be installed three 1,500-h.p. Westinghouse steam turbines of the latest design. These three machines will be the first of the new design to be installed for commercial service, and in view of the prevailing interest in the steam turbine question, a brief preliminary description of the new machine is here given.

The most striking constructive feature introduced in these machines is the separation of the high-pressure and low-pressure cylinders and the introduction between them of a reheater, an arrangement now employed in all Westinghouse turbines above 500 horsepower. This arrangement provides for a center bearing between the high-pressure and low-pressure cylinders, thus reducing the distance between bearings and allowing the use of a much lighter shaft.

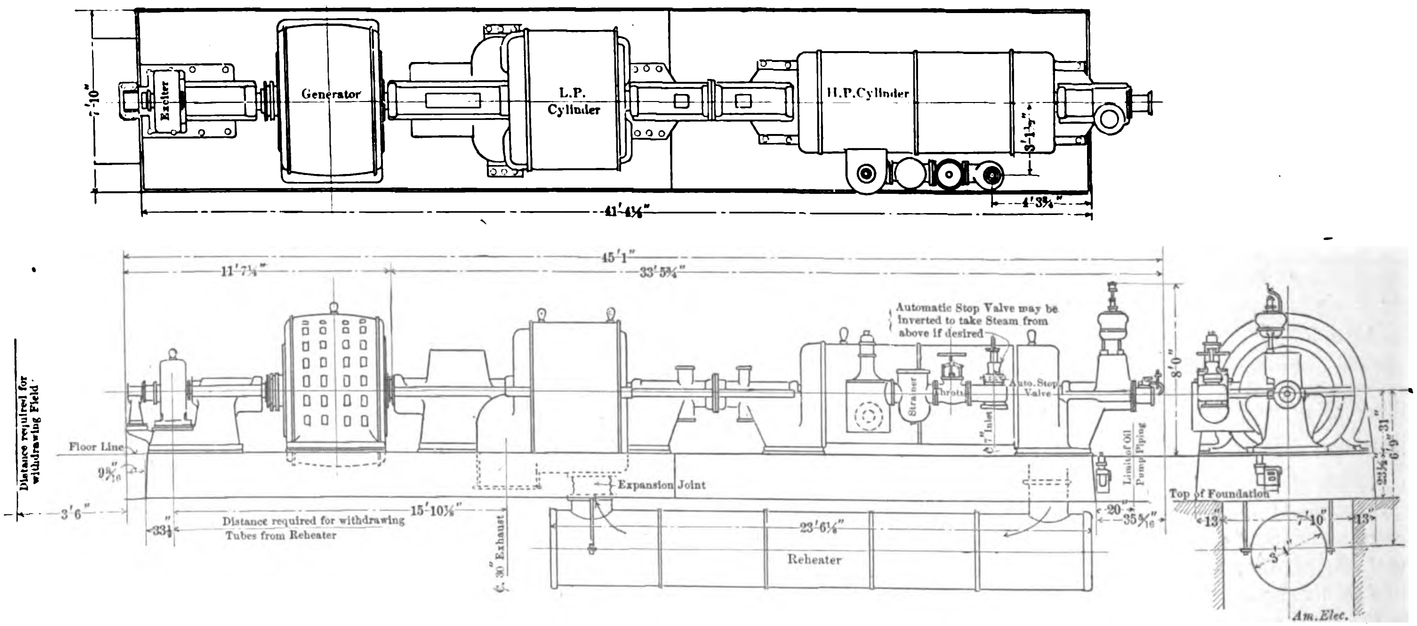

FIG. I.—PLAN AND ELEVATION OF WESTINGHOUSE STEAM TURBINE.

One of the important considerations in all steam engine work is the effect upon steam economy of entrained moisture. In the Westinghouse turbine this point has been taken care of effectively by the use of superheated steam wherever practicable. The excellence of the results derived therefrom have prompted the introduction in the largest machines of a reheater between the high and low-pressure cylinders, as is the practice in the construction of large reciprocating engines.

The turbine proper will be of the multiple-expansion, parallel-flow type, arranged, as above stated, in tandem. Steam entering at the throttle valve is passed through a strainer for removing all foreign matter, and thence through a poppet admission valve, the period of admission being controlled, as in former types, by a sensitive fly-ball governor. The steam, after admission, expands through successive rows of alternate moving and stationary sets of blades in the high-pressure cylinder. At a considerably reduced pressure and correspondingly augmented velocity, the working fluid then enters the reheater, where the entrained moisture is entirely re-evaporated, and passes to the low-pressure cylinder dry. Expansion through sets of blades or vanes takes place in the low-pressure cylinder, as in the high-pressure, with a consequent reduction of pressure and increase of velocity, and the exhaust steam, deprived of practically all of its available energy, escapes through the exhaust port, situated underneath the rear bearing of the low-pressure cylinder.

As in former types, a by-pass is provided, connecting the high-pressure and low-pressure cylinders, by means of which the turbine will be enabled to carry continuously an overload of 50 per cent. with the condenser, or full load without the aid of condensing apparatus.

The turbine shaft will be of open-hearth steel, and will be connected to the generator shaft by a special mechanical coupling. Provision for unconstrained alignment is further made by the use of special bearings, which are one of the most important features of the Westinghouse turbine. The bearing proper consists of a gun-metal sleeve immediately surrounding the shaft and provided with ducts for the distribution of the lubricating fluid. This sleeve fits closely within a second and concentric sleeve which resembles the ordinary self-aligning journal sleeve and rests in a spherical pocket in the pedestal.

The two journal sleeves are kept out of actual metallic contact by a thin intervening film of oil, which provides a cushion for the absorption of vibrations due to unavoidable eccentricities of rotation and a floating bearing for the moving parts, eliminating all but fluid friction. Although the two parts of the turbine are well balanced as regards axial thrust, some restriction of movement in this direction must be provided in order to prevent contact of rotating and stationary parts. For this purpose an adjustable thrust bearing will be mounted upon extensions of the turbine pedestals.

The governor will be of the fly-ball type, located at the extreme end of the turbine, and driven by worm gearing from the turbine shaft. It will be provided with a safety stop, which in combination with an auxiliary valve will automatically cut off the steam supply should the speed of the turbine exceed a predetermined limit. This stop is adjustable, and by its use any speed limit may be imposed upon the operation of the turbine equipment. A special governor attachment will enable the speed regulation to be adjusted from 1½ to 10 per cent. while running, according to the requirements of parallel operation.

A continuous circulation of lubricating oil will be obtained by a small pump, driven from the turbine shaft, which communicates with an oil reservoir located in the bedplate of the unit.

The bedplate will be of the heavily-ribbed, box type, and built in two parts which when bolted together will form a continuous machine surface for the mounting and aligning of turbines, generators and journals. This bedplate will rest upon a concrete foundation without the usual holding-down bolts necessary in reciprocating engine practice. A passageway extending throughout the entire length of the foundation is provided for the reception of the reheater, the shell of which extends only as far as the low-pressure cylinder. The remaining distance to the end of the foundation allows the removal and replacement of defective reheater tubes, if this should be found necessary. (See Fig. 1.)

The construction of the reheater is similar to that employed in the Westinghouse vertical and horizontal Corliss-type engines. The reheater for this turbine has a heating surface of 500 square feet, and is to be supplied with live steam from the boilers. A copper expansion coupling between the reheater and the low-pressure cylinder will be provided to prevent severe stresses due to unequal longitudinal expansion of the reheater and turbine.

For facilitating the starting of the turbine, a small by-pass around the throttle valve will permit the introduction of a small amount of live steam for warming up the cylinder walls and rotating parts.

The approximate performance under regular operation is represented in the accompanying curve sheet, which shows the general relations between load, steam consumption and superheat.

The alternator will be a six-pole, 1,000-kw., two-phase machine, of the revolving-field type, supplying current at 2,200 volts. The armature punchings will be retained in position by dovetailed extensions fitted into corresponding slots in the heavily-ribbed, cast-iron frames. The armature coils are wound, then cut and pushed into the partialy closed slots, and afterwards reconnected. The unit will run normally at 1,200 r. p. m., which, with the six poles, will yield a frequency of 60 cycles per second.

The field, or rotating part, is built up of steel sections assembled at right angles to the shaft. These sections are separated for ventilation purposes and a strap copper winding slipped over the poles thus formed, these being retained in position by steel pole-pieces bolted to the plates forming the magnet cores. The winding is one layer deep, as usual with this type of coil, the inside and outside being exposed to the air for the dissipation of heat. The exciter is to be located at the end of the turbine shaft, and will rest upon extensions of the generator pedestal, being driven directly from the turbine shaft by means of a suitable mechanical coupling. It will be a 30-kw. machine, of the usual direct-current type, generating current at 125 volts.

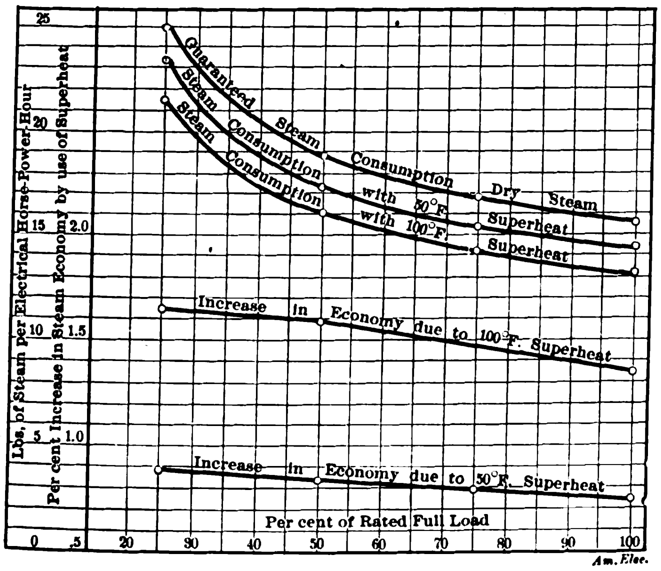

FIG. 2.—TURBINE CURVES.

The entire electrical equipment will be Westinghouse apparatus, and will be furnished and installed by Westinghouse, Church, Kerr & Co., who have designed the entire power system, including power stations, sub-stations, line and overhead systems. We are indebted to the courtesy of this firm and the Westinghouse Machine Company for the data given in this article.

THE PROTECTION OF SECONDARY ALTERNATING-CURRENT MAINS.

Two questions bearing on the subject of protecting secondary alternating-current circuits were discussed at the last Electric Light Convention. The first question was, "Is it not just as necessary to protect long services and interconnected secondaries from lightning as it is necessary to protect primaries?" Mr. W. J. Greene, of Cedar Rapids, Iowa, expressed the belief that it is necessary to give better protection to long services and interconnected secondaries than to primaries of equal length; otherwise the consumer's premises, with the usual low insulation from earth, would become a dangerous lightning arrester. Mr. C. R. Maunsell, of Topeka, Kans., said if it is desirable to ground secondaries, no lightning arresters would be necessary, particularly if the transformers work on the three-wire system with the neutral grounded. In this case, his company had found that no static discharge sufficient to do any damage can accumulate.

Professor Dugald C. Jackson said that an affirmative answer to the question is almost self-evident if the following considerations are remembered. The location and length of the line being fixed, the chance of serious increase of pressure due to the lightning discharges is equally great, regardless of the working pressure to which the line is subjected in normal service. Secondary lines have in the past usually been of comparatively limited length or their location has been protected, and for this reason lightning protection has not always been found essential. The primary lines, on the other hand, have been more extended and in more exposed positions, and experience has shown that lightning protection with them is essential. This need is particularly caused, however, by the length and exposure of the lines and is not indissolubly linked with the higher working pressure which they carry. Cribbed or interconnected secondaries of great length have lately come into general use with better alternating current plants, and such secondaries, when overhead, require a protection from lightning which is the full equivalent of the protection of primary lines.

The necessity for the protection of the secondaries sometimes is not felt so acutely as the necessity for the protection of the primaries because a serious arc due to the generator e.m.f. will not always follow every slight injury to the insulation of the secondary wiring which may be caused by lightning. Such an injury, however, will almost always cause trouble ultimately, and perhaps result in serious damage. This possibility can only be avoided by the proper protection of extended secondary and service wiring from the effects of lightning.

Mr. E. J. Bechtel, of Toledo, said his company had no lightning arresters on its interconnected secondaries (the longest being between three and four miles of three-wire mains) and has had no trouble chargeable to this cause since the system was started in 1897. He had not fully decided. however, that this is the proper method.

The other question was: "What form of lightning arrester best lends itself to use upon secondary circuits?" Professor D. C. Jackson, of Madison, Wis., pointed out that this question is more difficult to answer than the first one. He thought, however, that it was safe to recommend that the lightning arresters should be of one of the following types: (1) Cylinder non-arcing type, with very narrow air gap and non-inductive resistance in series therewith; (2) a type with electromagnetic arc interrupter and non-inductive shunt for a path for the lightning around the electromagnetic coil; (3) perhaps a type depending upon a high resistance leak, like the Wurts charred wood arrester. Any one of these types properly made to protect low pressure lines ought to serve the purpose admirably, and their construction admits of their being placed upon the pole line in boxes. The manufacturers ought to pay more attention to the requirements to be met in this service.

In the oral discussion which followed, Captain Wm. Brophy, of Boston, said that one serious difficulty in making lightning arresters efficient when the transformer is placed on poles or outside of buildings, as they usually are, is the matter of the convenience of having a grounded connection at all times. A ground wire running a long distance on a building, or if it is run down a pole, is apt to be broken and renders the lightning arrester useless. So long as transformers are so placed, he thought the lightning arrester would be rather inefficient and unreliable. Again, it would be very difficult to get a good ground at the bottom of the pole. The only reliable ground—which is really not a "ground"—is a connection with the water system of the city. Most of the ground should be taken down and connected with plates at the bottom, the plates or bars with which connection is made, being driven down into the soil.

Mr. J. Walter Gillette, of Evansville, Ind., asked if it would not be good practice in running a ground wire from a lightning arrester through an iron pipe, to see that a positive connection was made to the ground wire at the top of the pipe and in cases where the pipe follows to the earth, to stop the choking of the iron pipe through the conductor, where an iron pipe is used as a protection to the copper wire alongside the pole. In reply to this question, Captain Brophy said that it would be far better to use the iron pipe as the conductor, carrying the pipe to the transformer and connecting the ground wire to the pipe, and not using wire inside the pipe. If he were going to use copper wire, he would advise grounding the wire at the top of the pipe.

Abstracts from Foreign Contemporaries

Arc Light for Projection Apparatus.—The experience gained in the electric illumination of lighthouses has shown that the carbon arc in its ordinary form does not give a sufficiently steady and uniformly distributed light to work well with mirrors and lenses designed to give a well-defined cone. It was, therefore, proposed to mount the vertical carbons in such a way that the point of the negative carbon was vertically below the front surface of the positive carbon. No crater is then formed, and the positive carbon burns away in a slanting section. Since, however, the light, with the vertical position, is sent out mostly below the horizontal plane, H. Krüss has further endeavored to find an arrangement whereby the light may be distributed as evenly as possible; and he recommends in a recent issue of the *Physikalische Zeitschrift* that the front surfaces of the carbons should be in the same plane, and both inclined at an angle of 30° with the vertical. He has designed the hand regulator, shown by Fig. 1 herewith. for projection apparatus, the upper carbon, *B*, being shifted by means of the handle *C*, while both carbons may be raised or lowered by means of the handle *D*.

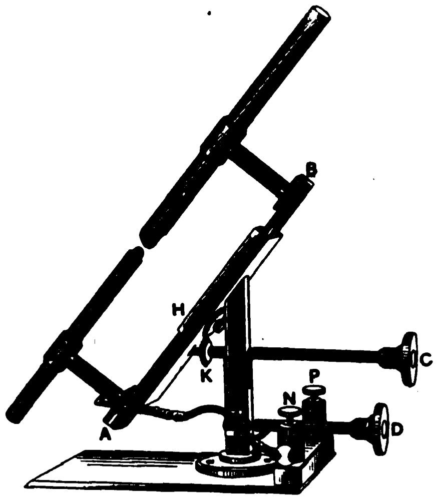

FIG. 1.—PROJECTION LAMP.

Economical Effect of Receiver Reheating. —In a paper read by Prof. R. L. Weighton before the Institution of Mechanical Engineers, and reprinted in our English contemporaries, are set forth the results of certain trials on the effect of receiver reheating carried out at the Durham College of Science, with a small steam engine provided for experimental purposes. The cylinders used for these trials were 7 ins. and 15½ ins. in diameter, with a stroke of 18 ins. The boiler pressure was maintained constant throughout the trials at 200 lbs. A reheater was specially fitted to the engine for the purpose of these trials, as shown in Fig. 2. The heating surface consisted of a double coil of copper piping arranged inside a cast-iron chamber, and amounted to 30 sq. ft. The receiver steam was compelled to pass through the heater by blocking up the middle cylinder and ports, as indicated in the engraving. Steam under boiler pressure was admitted to the inside of the heater coils, and the water condensed in these coils was tapped at a lower level and carefully measured, besides being periodically drained off, so as to keep the coils absolutely clear of water. The receiver condensation was similarly dealt with. In order to test the effect of the reheating at different loads, the power of the engine was varied by varying the cut-off in the high-pressure cylinder, the low-pressure cut-off remaining constant throughout at 7 ins. The engine was normally fitted with Meyer expansion valves, but it so happened that prior to these trials and for other purposes, the high-pressure cylinder had been fitted with a shifting eccentric in imitation of the action of an automatic expansion governor. This eccentric was retained for the reheating trials, but was shifted by hand to give the variations in power. No governor was attached to the engine. To preserve as great a uniformity of conditions as possible, the experiments were made in pairs, the only change between the two trials of each pair being that the steam was shut off in one from the reheating coils, while in the other steam was admitted to the coils. Sufficient time was allowed to elapse between the trials to permit of the attainment of thermodynamic stability under the changed condition. In this way only has the author found it possible to obtain consistent results in any series of experiments where the differences in effects due to given changes in conditions are small. The dynamometer was adjusted to give as nearly as possible 133 r.p.m. for the first trial of a pair, the steam being shut off from the heater coils and the receiver steam passing through the heater on its way to the low-pressure cylinder. Under these conditions a trial was run and the observations and measurements recorded. Immediately on finishing steam was admitted to the reheater coils and the engine permitted to run until it adjusted itself to the new conditions. no other change whatever being made as compared with the trial just completed. The vacuum was kept as nearly as possible constant throughout all the trials.

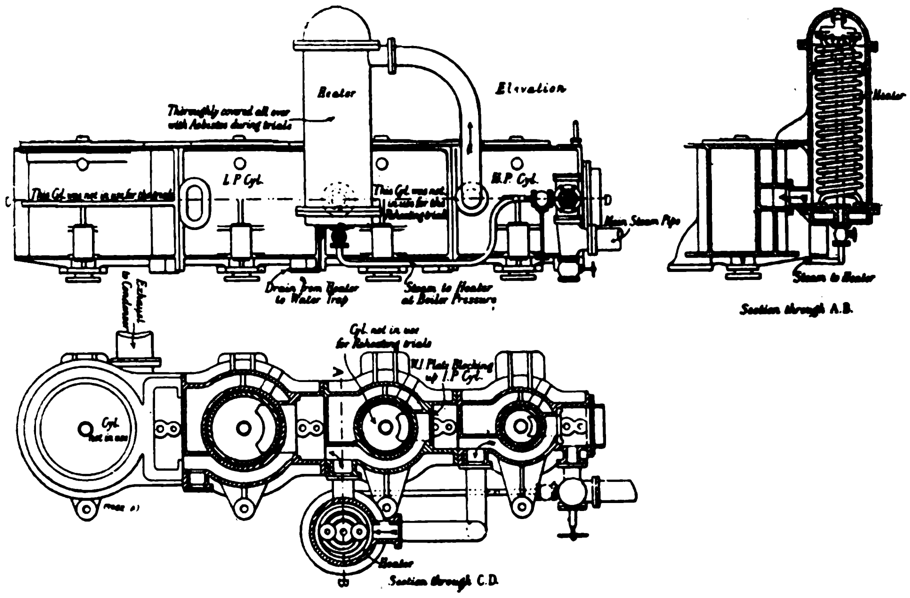
Heater
Elevation
Thoroughly covered all over with Asbestos during trials
L P Cyl.
This Cyl. was not in use for the trials
This Cyl. was not in use for the Reheating trials
H.P. Cyl.
C
D
Main Steam Pipe
Heater
Steam to Heater
Section through A.B.
Exhaust to Condenser
Drain from Heater to Water Trap
Steam to Heater at Boiler Pressure
Cyl. not in use for Reheating trials
W.I. Plate Blocking up I.P. Cyl.
Cyl. not in use
Heater
Section through C.D.

FIG. 2.—ARRANGEMENT OF REHEATER AND ENGINE.

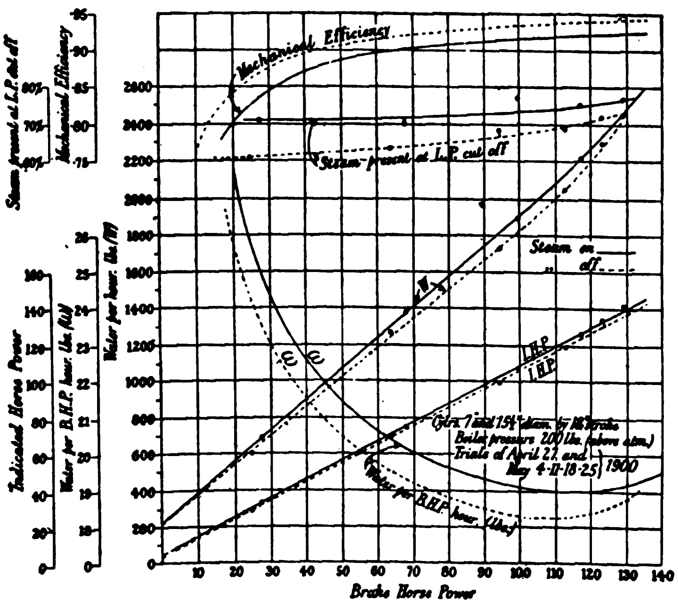

FIG. 3.—PLOTTED RESULTS OF REHEATER TRIALS.

The result of the trials is recorded graphically in Fig. 3, and attention is directed to the following points: (1) The amount of condensation per hour in the heater coils seems to be independent of the difference of temperature between the heating and the heated steam, and would appear to depend chiefly upon the quantity of heated steam. From the tabulated results given by the author it would appear that as the power diminishes so does the quantity condensed in the coils diminish, and this in spite of the fact that the temperature difference increases as the power grows less. (2) The influence of the reheater is very marked in respect of the following, namely: reducing the amount of condensation in the receiver; raising the receiver pressure; raising the mean pressure throughout the engines; increasing the speed of the engines, and increasing the dryness of the steam acting in the low-pressure cylinder. These may be ranked as effects which are in themselves favorable to the attainment of economy. (3) The influence of the reheater is, however, equally marked in effects which are detrimental to economy, namely: lowering the mechanical efficiency of the engines, and increasing the steam consumption per horse-power developed. The consumption per brake horse-power is in all cases consistently greater when the heater is in use, the average increase being 2.6 per cent. against the heater. The economic effect of the heater in terms of water per indicated horsepower is very small, being an average of 0.18 per cent. against the heater. From the tabulated results it is also evident that in every case a lessened mechanical efficiency is associated with the use of the reheater, the average adverse effect being 2.2 per cent. The cause of this very undesirable effect is doubtless to be found in the greater dryness of the working steam after passing through the reheater when steam is in the coils. The result here obtained shows the necessity for stating steam engine efficiency in terms of brake horse-power instead of indicated horse-power, especially in those cases where steam-drying arrangements or devices are employed. The paper is interesting in that, contrary to theory, it shows an engine to be better off without than with a reheater. Its prominent feature is its implicit repudiation of the doctrine still held by many that reheating steam must be a source of economy; and a high vacuum equivalent to a rise in average pressure obtained for nothing.

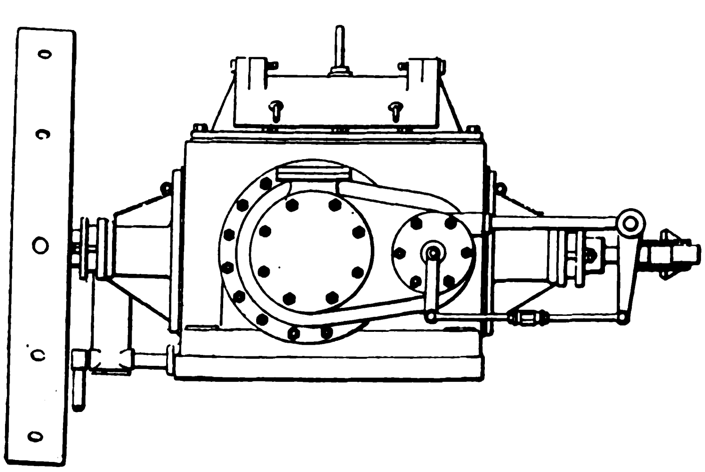

FIG. 5.—END VIEW OF HIGH-SPEED ENGINE.

High-Speed Steam Engine.—In a recent issue of the London *Engineer* is given a description of the latest development of Bever's patent balanced engine, the principal feature of which is that the engine is so arranged that all the working parts are balanced both as regards weights and pressures. There are, as will be seen by reference to Fig. 4, two pairs of cylinders, high-pressure and low-pressure, placed tandem on each side of the crank shaft; the pistons of each pair of cylinders being fixed to piston rods having cross-heads working in bored guides formed in the center casing of the engine. These crossheads are of steel, having shoes of very wide area, lined with white metal. Stuffing boxes are provided in the high and low-pressure cylinders, and also the low-pressure cylinder covers, these being fitted with metallic packing. The crossheads are connected to the crank pins on one side by a straight connecting rod coupled to the center of three crank pins, and on the other side by a forked connecting rod coupling to the two outer crank pins, which latter are set opposite to the center pin. By this arrangement the pressures from the two sides are said to be absolutely balanced, that on the shaft bearing being reduced to zero and all the pressure being taken up by the connecting rods. These, and the other reciprocating parts on both sides being of equal weight, are also balanced. In consequence of this balancing of pressures and weights the makers claim that the engine will be able to run at much higher speed than any other high-pressure engine, enabling lighter, smaller and more efficient dynamos to be used. At a speed of 800 r.p.m. there is said to be a remarkable absence of vibration. The valves are of the piston type, and are worked by eccentrics fixed on the main shaft. Steam is admitted to the high and low-pressure cylinders in such a way that it expands three times. In the high-pressure cylinder the steam is cut off at about half stroke on the front side of the high-pressure piston, and after expansion is admitted to the low-pressure back end and is there again cut off at about half stroke and expanded, being thence admitted to the front end of the low-pressure piston after the manner of the old Cornish engine; thus expanding three times with only two pistons. The back of the high-pressure piston is always under full boiler pressure, thus maintaining a constant thrust on the connecting rods. The engine is controlled by a sensitive high-speed governor connected to the throttle valves, which are placed in the piston valve chamber, and so arranged that the steam is not throttled until after it has acted on the back of the high-pressure pis-

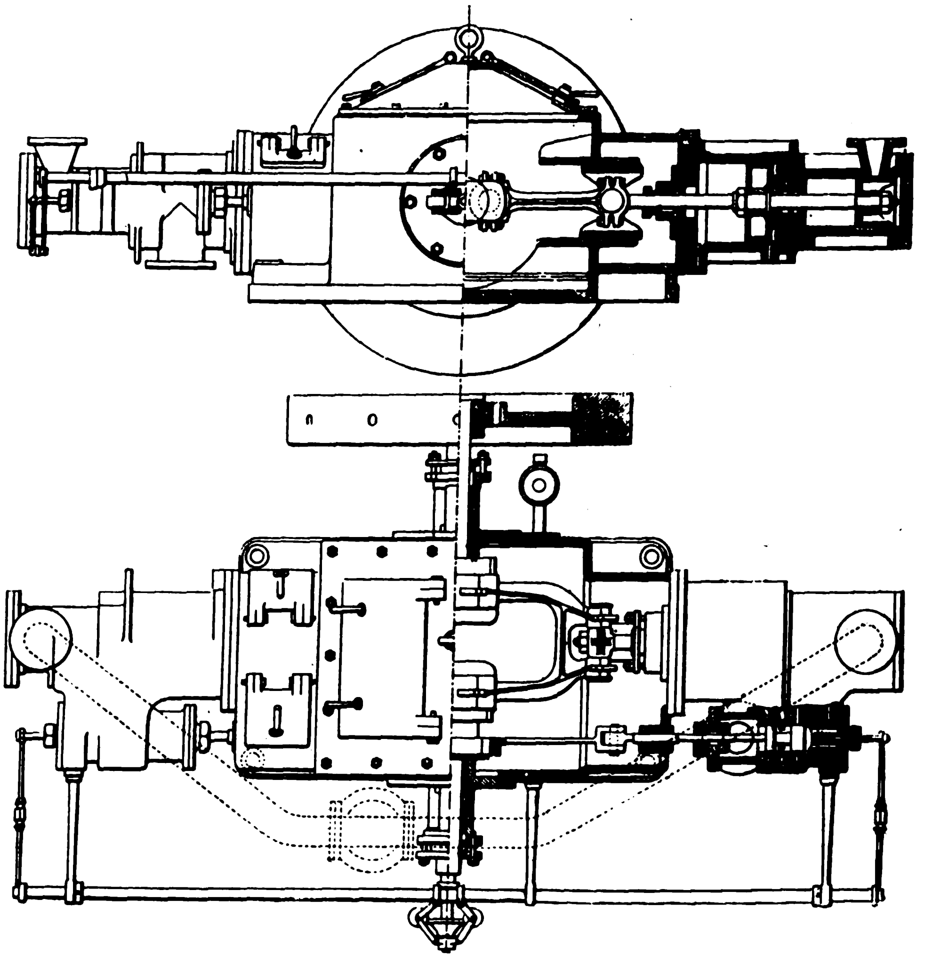

FIG. 4.—HIGH-SPEED STEAM ENGINE.

ton, so as to maintain a constant thrust. All of the moving parts of the engine run in a bath of oil, thus ensuring perfect lubrication, the splash of the oil also feeding the crank shaft bearings. Fig. 5 shows an end view of the engine.

Oil and Grease Separator.—London *Engineering* describes an oil and grease separator for the exhaust of condensing engines, which is in many respects novel in design, and for which exceptional efficiency is claimed on account of the care with which the details have been worked out to prevent the grease when once precipitated from being again picked up by the steam and carried forward, or from creeping along the inside of the casting, as it is apt to do. Fig. 6 shows the complete apparatus; steam entering at the left and leaving at the right. To the right of the engraving are given vertical and horizontal sections of the separator itself. It will be noticed that wherever oil is likely to strike or to creep along the surface, provision is made for trapping it; thus where the steam pipe joins the separator and the area is constricted, there is a flange, *A*, to prevent the oil which creeps along the sides of the pipe from entering the interior of the separator. This flange diverts the oil into a trap, which is connected by a pipe, *B*, to a tank. Similarly, at the exit of the separator there is a second flange, *C*, for the same purpose. Facing the inlet there is a diverging baffle-plate, *D*, with projecting ribs and provided with an enclosed chamber behind, through which cold water is circulated by the pipes *E* and *F*, the object being to keep the baffle-plate cool and moist, thus assuring the adhesion of oily particles. The exhaust steam entering the separator is diverted to the right and left by the baffle-plate. The momentum of the liquid particles brings them in contact with the baffle-plate, where they are diverted inwardly and immediately removed from the course of the steam. It is, therefore, hardly possible for any of the separated particles to be again picked up by the steam and carried to the separator. To avoid risk of any considerable back pressure, it will be noticed that there is only a small diversion of the course of the steam. The diagram to the left illustrates the separator connected up to an automatic alarm discharge tank. This tank is connected to a live steam pipe, *G*, and when the tank is full, the ball rises and causes a steam whistle to sound. The tank is then discharged by an attendant by means of live steam. The advantages of this arrangement are that the alarm is automatically sounded when attention is necessary, and further when communication with the exhaust pipe is reopened steam, and not air, is admitted.

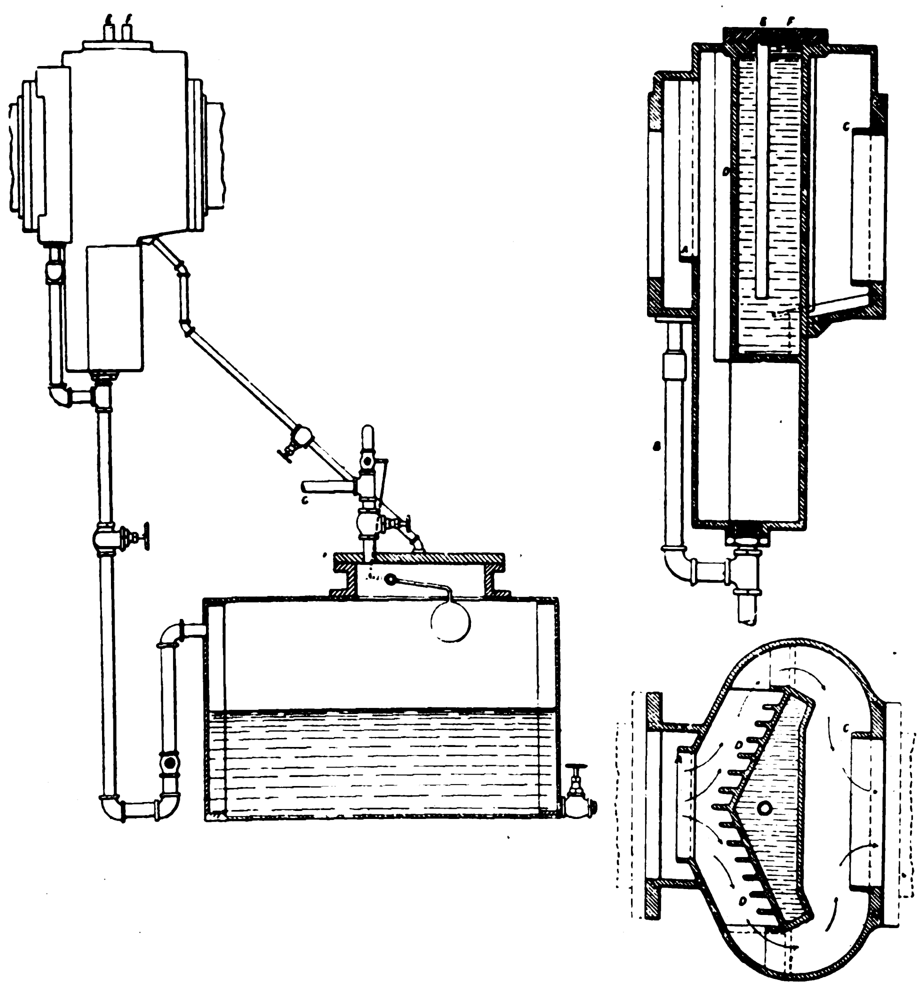

FIG. 6.—OIL AND GREASE SEPARATOR.

Giovenale Pressure Regulator.—*L'Elettricita* describes a novel piece of apparatus, shown by Fig. 7 herewith, which is intended for use in connection with high-pressure installations where it is necessary to see at a glance the condition of the circuit. It consists of a wire of plated brass, bent and welded as shown. In the middle of the ring formed at one end is a disc of aluminum, mounted in such a way that it is free to rotate. One end of the disc is slightly heavier than the other, so as to keep it in a vertical position within the ring in which it is carried. When a charge of electricity is given to the apparatus, the disc tends to move away from the fixed part. The long leg of the device enables the instrument to be applied to any desired apparatus by fastening it to terminals or suspending it freely. Its use is claimed to be particularly advantageous in transformer stations. On noting a shortage of energy in a transformer station, the transformer is examined, but it is not apparent whether the loss has taken place in the conductor, fuses or in the transformer itself. By fixing the Giovenale indicators on the ends of each fuse the point at which the leakage has taken place will be clearly seen. Referring to Fig. 7, if the disc at *A* does not move, it is a sign that the conductor is not charged; if *A* moves while the disc at *B* remains stationary, it is clear that the fuse has blown; if both the discs *A* and *B* move, the leakage must be sought for in the transformer. In a polyphase plant, it is easy to determine the fuse that has blown. When one fuse, say *A*, has blown, and the other remains in order, the electric condition is still maintained in *B*, since the latter is in contact with primary wires joined together at the neutral point, the fuse of which remains intact. The potential, however, is much lower than that at *A*, and, therefore, the disc in the indicator *B* moves much less than that in *A*, thus indicating which is the faulty fuse. It would appear that the sensitiveness of these indicators should be commensurate with the pressure of the plant at which they are used. They can easily be made for plants generating 200 volts and upwards, and, if necessary, the sensitiveness may be increased in various ways, and thus adapted to lower pressures. Both of the illustrations show the indicator as it appears when charged.

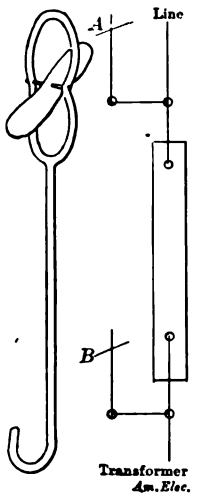

FIG. 7.

Utilization of Exhaust Steam.—A remarkable instance of a successful reclamation of waste energy is described in a recent issue of *l'Industrie Electrique*. At the mines of Druay, on the Straits of Dover, the exhaust steam from the hauling engines had heretofore been allowed to escape to the atmosphere, the intermittent operation of the engines and the difficulty of applying an efficient expansion rendering condensation impracticable. A Rateau steam turbine was, however, installed, and driven by the steam from the low-pressure cylinder of the main engine. The turbine is coupled to two 100-

kw dynamos, which run at a speed of 1,600 r. p. m., and generate current at a pressure of 240 volts. The turbine consists of seven discs of 90 cm. in diameter, fitted with vanes, the outer case being 110 cm. in diameter and 120 cm. long. The steam pressure on admission to the turbine is below that of the atmosphere; at trials made, it was found to be about 13 lbs. per square inch, absolute. The turbine exhausts into a condenser at a pressure of 3 lbs. per square inch. Under these conditions an output of 310 electric horse-power was obtained, with a consumption of 40 lbs. per electric horse-power-hour. In order to overcome the irregularity of the steam supply, due to the intermittent working of the main engines, a novel form of regenerator was devised by the builders of the turbine. This consisted simply of an old boiler filled with several tons of scrap iron. In passing through this the steam gave up part of its heat, falling, for example, from 195° C. to 98° C. When the main engines stop, the process is reversed, the condensed steam being re-evaporated. Provided the stoppages of the main engines are not too protracted, a practically uniform supply of steam for the turbine is obtained by this means. When necessary, however, steam may be supplied direct from the boilers through a reducing valve. Although particulars as to the size of the main engines and the actual total cost of the energy reclaimed are wanting, the installation is worthy of note in that it shows that in the turbine, expansion can be carried to a much higher degree than in the steam engine without disadvantage; for, as is well known, in the latter it is not economical to expand steam below a pressure approximately equal to that which is necessary to overcome the friction of the engine.

Some Recent Electrical Patents

System of Constant-Current Distribution.—A patent has been issued to John F. Kelly, of the Stanley Electric Manufacturing Company, for the system of constant-current distribution illustrated diagrammatically in Fig. 1. The system consists briefly of the use of a motor-dynamo set, the motor, *B*, being a synchronous alternating-current machine, and the dynamo, *C*, being a constant-current alternator. The object of this arrangement is to prevent reaction upon the main line by highly inductive devices in the lamp circuit. In view of the use for six or seven years of synchronous motors and direct-current arc-light machines in exactly the same manner illustrated, together with the fact that the application for the present patent was filed May 20, 1902, the first two claims of the patent are especially noteworthy. These cover a combination of a constant-potential alternating-current generator, a synchronous motor supplied thereby, and a constant-current generator driven by the synchronous motor and supplying translating devices in series. Patent No. 707,334.

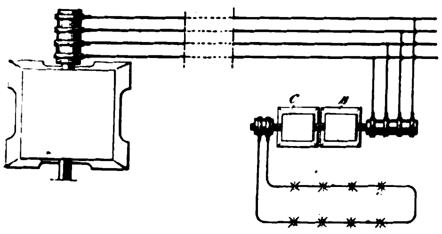

FIG. 1.—CONSTANT CURRENT DISTRIBUTION.

Carbon Brush Holder.—The Baylis reaction carbon brush-holder has become familiar to all users and attendants of direct-current dynamos and motors. A rather clever modification of this type of brush-holder has been patented by Walter J. Richards, and is illustrated by Fig. 2 herewith. The brush is pressed toward the commutator by the finger *j* under the influence of a coil spring about the spindle *e*, exactly as in the case of the Baylis holder. The pressure of the finger, however, differs from that of the Baylis holder in that it is substantially parallel with the travel of the brush. An additional finger, *l*, is provided, which carries a curved flat spring, *m*, at its outer end, the latter serving to keep the brush in firm contact with the brass plate on which it slides. The finger *l* is provided with a lug, *n*, which comes in contact with the end of the holder plate in time to prevent the tip of the spring *m* from coming into contact with the commutator. The end of the finger *j* in contact with the brush is formed into a cross-bar, *k*, which is more clearly shown in the plan view of the brush-holder at the lower part of the engraving. This cross-bar has two functions, one to distribute the pressure on the brush, and the other to restrict the forward motion of the finger *l* carrying the curved flat spring. Patent No. 708,664.

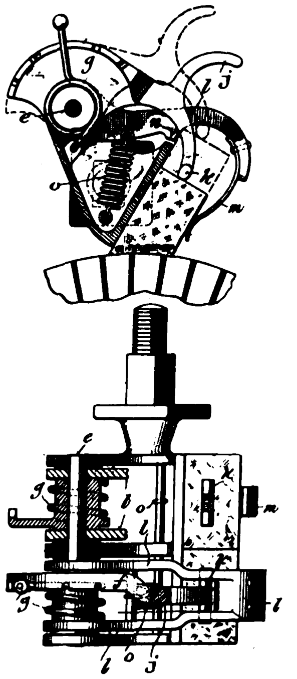

FIG. 2.—CARBON BRUSH HOLDER.

Series Arc Lighting System.—As is well-known, the chief disadvantage inherent in the alternating-current arc-lighting system comprising a series of lamps supplied with constant current directly from a constant-potential circuit through the intermediary of an adjustable reactance, lies in the fact that the potential of the arc-lamp circuit, as ordinarily operated, is limited to the e.m.f. of the constant-potential supply. Fig. 3 illustrates diagrammatically the fundamental features of a system which has been patented by Richard Fleming, and in which the disadvantage just noted is greatly reduced if not entirely eliminated. The illustration referred to shows only two arc lamps, but of course any desired number may be operated within the limits of the system. An automatically-adjusted reactance, *7*, is connected in series with the lamps in the usual manner, in order to maintain the current substantially constant. The means by which the potential of the arc-lighting circuit is rendered almost independent of that of the constant-potential supply consists of auto-transformers, *10* and *14*, to the terminals of each of which a lamp is connected. The circuit, however, is connected to one terminal of each coil and to an intermediate point in the coil, so that the difference of potential between the points *11* and *12*, to which the line is connected, is much less than the difference of potential at the terminals of the lamp; consequently, the difference of potential at the terminals of the entire circuit is correspondingly less than the added differences of potential of the individual lamps. Fig. 4 indicates somewhat more fully the arrangement which the inventor proposes to use at each lamp. The

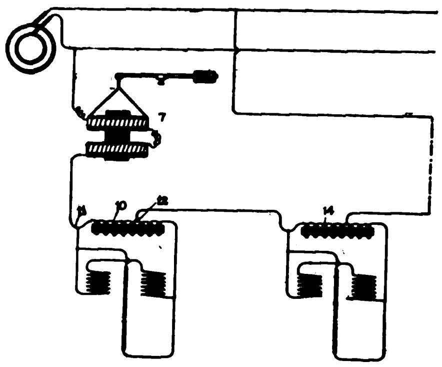

FIG. 3.—SERIES ARC LIGHTING SYSTEM.

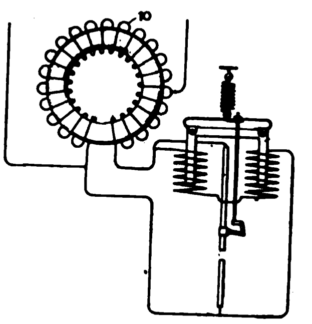

FIG. 4.—LAMP CONNECTIONS.

auto-transformer is shown here with a circular core, around which is a winding, *10*. The lamp is connected to the extreme terminals of this winding, while one of the circuit leads is connected to an intermediate point, exactly as in the diagram of Fig. 4. Patent No. 706,544.

Arc Lamp.—It is almost universally the custom in arc-lamp practice to allow the upper carbon to feed by gravity by releasing a clutch which normally holds the carbon up so long as the arc is of the proper length. It is also becoming quite common practice to mount the upper carbon directly on the core of a solenoid somewhat after the style of the Pilsen lamp, the solenoid being mounted in series with the arc on a constant-potential circuit. A lamp belonging broadly in this latter class, but departing considerably from the ordinary method of feeding, has been patented by George G. Tilden, and is illustrated by Figs. 5 and 6, herewith. Fig. 5 shows a simple gravity feed. The solenoid plunger is hollow, forming a socket for the upper carbon, which is held in the socket by means of the star-wheel, 7, and the spring, 17. This form of lamp is of the simple series type, so that when the arc becomes too long the solenoid is weakened and allows the plunger, 3, to fall a trifle. The distance through which the solenoid descends is much less, however, than would be the case if the carbon were fastened solidly to it. The downward movement of the plunger causes the arm, 9, to come in contact with the stop, 11, shown more clearly in the detail at the left. This raises the arm and causes the pawl, 19, to turn the ratchet-wheel, 8. The star-wheel, 7, is mounted on the same spindle with the ratchet, so that when the latter turns, clockwise, the star-wheel feeds the carbon downward within the plunger, so that the distance through which the carbon is fed is considerably greater than the distance through which the solenoid plunger descends. Fig. 6 shows this method of feeding in connection with a shunt magnet. In this case, when there is a single lamp in circuit there is a compound feeding action due to the weakening of the series solenoid, 2, and the strengthening of the shunt solenoid, 24, when the arc lengthens. Patent No. 701,423.

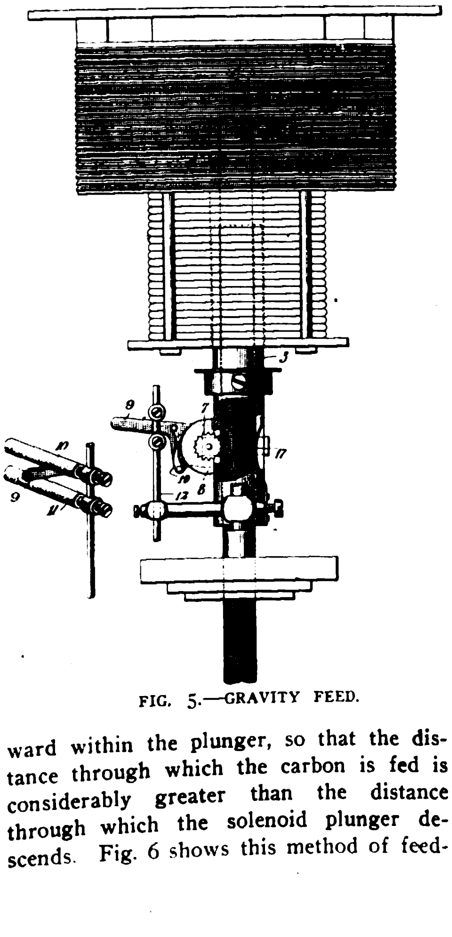

FIG. 5.—GRAVITY FEED.

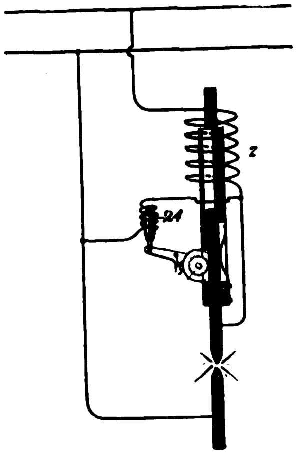

FIG. 6.—FEEDING WITH SHUNT MAGNET.

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NOTES.

High Voltage Incandescent Lighting.—The University of Illinois has taken advantage of the perfection of the 220-volt incandescent lamp and the recent revision of the National Electrical Code of the Fire Underwriters permitting the use of 500-volt distribution within buildings, by installing a 440-volt plant for the lighting of five new buildings at Champaign. Two-phase alternating current will be used and each phase will be treated as a single-phase circuit, operated on the three-wire plan with the neutral wire tapped into the middle of an auto-transformer winding. The generating station contains two belted two-phase alternators, one of 50 kilowatts and one of 75 kilowatts capacity, which deliver current at 440 volts, to which will shortly be added a 120-kw. Westinghouse alternator, of the revolving-field type, direct-connected.

Master Steam Boiler Makers' Association.—There was founded in Chicago early in this year an organization, composed entirely of practical men, which was given the name of the Master Steam Boiler Makers' Association. The first convention of the association will be held in Chicago at the Great Northern Hotel, October 9, 10 and 11, and the character of the projected programme augurs extremely well for the future of the association. It is the desire of the organizers to secure the membership of every eligible man engaged in practical boiler construction, and it is to be hoped that this ambition will be realized. The association will issue an official journal, the title of which is to be *Motive Power*, and the subscription price $1 per year. The officers for the first year are T. C. Best, president; William M. Wilson, vice-president; George M. Clark, secretary, and J. J. Boyce, treasurer, all of Chicago.

Factor of Safety in Fly-Wheels—A short but interesting article by William H. Boehm, superintendent of the Fly-wheel Department of the Fidelity & Casualty Company, was published in a recent issue of the monthly bulletin of that company. In this article Mr. Boehm pointed out the advisability when designing fly-wheels of making the factor of safety applicable to the speed instead of to the strength of the material. As the danger from racing increases with the square of the velocity and only directly with the weight of the material, it is obvious that a very large factor of safety as applied to the weight or strength is equivalent only to a relatively small one with respect to the speed. Mr. Boehm cites as an example the fact that if the engine should race and the speed be tripled, the stress in the fly-wheel rim will become nine times greater than at normal speed, so that unless the factor of safety with regard to strength were made 9 or more, the wheel would be disrupted, although the increase in speed would only be as 3 to 1.

The American Institute Library.—Mr. C. O. Mailloux, who made generous contributions to the library of the American Institute of Electrical Engineers some months ago, has supplemented his earlier donations with a check for $1028.23, to cover the cost of the following additions to the library:

Memoires de l'Academie des Sciences. New Series. Half morocco; 1816 to 1900; 45 vols. and general index.

Memoires Presentes par Divers Savants a l'Academie des Sciences. New Series. Half morocco (bound at the expense of Mr. Mailloux). 31 vols.; 1827 to 1894.

Annales de Chimie et Physique. Bound. 303 vols.; 1789 to 1900, and 9 vols. of indexes.

Journal de Physique. Half morocco (bound at the expense of Mr. Mailloux). 1872 to 1900; 29 vols.

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Recueil de Memoires. Memoires read before leading European scientific societies. 1754 to 1770; 4 vols.

Histoire et Memoires de l'Academie Royale des Sciences. Bound. 1666 to 1778; 171 vols.

Abridgement of Histoire et Memoires de l'Academie Royale des Sciences. 1666 to 1718; bound in one volume.

The Philosophical History and Memoires of the Royal Academy of Sciences at Paris. English abridgement. Five vols. 1699 to 1720, bound 1742. To be bound at the expense of Mr. Mailloux.

Histoire de l'Academie des Sciences. By Maindron, 1888. Half morocco (bound at the expense of Mr. Mailloux).

Zeitschrift des Oesterr. Ingenieurs und Architeken Verein. Bound. 1855 to 1901. Both weekly and monthly editions.

Zeitschrift für Instrumentenkunde. 1881 to 1901; 21 vols.

Mr. Mailloux has also expressed the desire to donate a sum of money, the annual proceeds of which will be sufficient to pay the future cost of subscription to such of the periodical publications he has presented to the Library that are yet current, and also defray the cost of binding the same.

American Street Railway Association. At the twenty-first annual meeting of this association, to be held in Detroit, Mich., October 8, 9 and 10, papers will be read on the following subjects by the authors named: "The Registration of Transfers," by C. D. Meenely, of the Brooklyn Heights Railroad Company; "Benefit Associations," by Oren W. Root, Jr., of the Metropolitan Street Railway Company, New York; "Discipline of Employees by the Merit System," by W. A. Satterlee, of the Metropolitan Street Railway Company, Kansas City; "The Transportation of Light Express and Parcel Delivery," by George W. Parker, of the Detroit United Railway; "Steam Turbine Engines," by E. H. Sniffin, New York; "Signals for Urban and Interurban Railways," author not given, and "The Adjustment of Damage Claims," by M. B. Starring, of the Chicago City Railway Company. Thursday, October 9, has been set apart as exhibitors' day, on which no session of the association will be held, so that all delegates may have ample opportunities to inspect the exhibits.

International Association of Municipal Electricians.—This association will hold its seventh annual convention in Richmond, Va., October 7, 8 and 9. The papers scheduled for presentation are as follows: "Municipal Inspection and Control," by Walter M. Petty, Superintendent Fire Telegraph, Rutherford, N. J.; "Relation of Electrical Interests to other Branches of the Municipality," by Captain Wm. Brophy, Boston, Mass.; "Classifying of Records of Electrical Departments and Standard Specifications for Supplies and Contracts," by Edward F. Schurig, City Electrician, Omaha, Neb.; "Report of Committee on rules for Electrical Inspection and Control, Especially with Reference to the Occupancy of Streets," by Morris W. Mead, Superintendent Bureau of Electricity, Pittsburg, Pa.; "The Telephone Service in Connection with Fire and Police Signal Systems," by Jerry Murphy, Superintendent Police Telegraph, Cleveland, Ohio; "Electrical Government," by A. S. Hatch, Assistant Superintendent Public Lighting Commission, Detroit, Mich., and "Joint Use of Conduits," by Charles F. Hopewell, City Electrician, Cambridge, Mass. Mr. Hopewell will also give an illustrated lecture on fire and police telegraph. Special rates have been secured at the various hotels and from the principal transportation companies.

A Single-Phase Alternating-Current Interurban Railway.—The Washington, Baltimore & Annapolis Electric Railway Company has contracted for the electrical equipment of a railway line between Washington and Baltimore, with a branch at Annapolis, which equipment will embody some radical departures from established railway practice. The power house will be located at Hyatsville, and the generators will be single-phase Westinghouse alternators of 1500 kilowatts capacity each. Current will be transmitted at an e.m.f. of 15,000 volts to transformer stations located at suitable intervals along the line, where the e.m.f. will be reduced and delivered to the trolley wire at 1000 volts; the frequency is to be 16 2-3 cycles per second. The car equipment is the most radical feature of the system, as it includes series-wound alternating-current motors very similar to the ordinary direct-current railway motor. There will be four motors per car, each capable of an output of 100 horsepower. The motors are not subjected to the full potential of the line, but are built for a normal e.m.f. of 220 volts each; they will be connected permanently in series-parallel, as indicated in Fig. 2 herewith, so that the maximum over-all voltage of the motors will be about 440. In the engraving *e* represents the armature; *d*, the field windings; *c*, a reversing switch; *b*, an inductive regulator, and *a* an auto-transformer. The two latter pieces of apparatus are for the purpose of speed control. The armatures are provided with equalizing connections and an equalizing transformer, *f*, by means of which all the armatures are subjected to the same e.m.f.

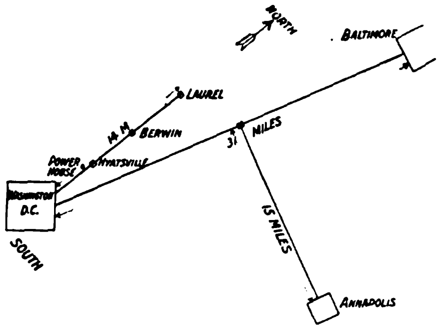

FIG. 1.—LOCATION OF TRANSFORMER STATIONS.

The motors are eight-pole machines, and are provided, of course, with finely-laminated field-magnet structures, as the field is excited by alternating current. The inductive regulator, *b*, constitutes the controller of the car, and enables the motorman to either reduce or increase the voltage at the terminals of the motors. The auto-transformer will supply current at the secondary terminals of the motors. The auto-transsecondary circuit of the controller or inductive regulator will be wound for a maximum of 100 volts, so that the terminal voltage at the motors can be varied from approximately 200 volts up to a little over 400 volts. In a paper read by Mr. B. G. Lamme before the American Institute of Electrical Engineers on September 26, it was explained that commutation difficulties have been overcome by so designing the motors that the short-circuit current in an armature coil undergoing commutation is very small. Fig. 3 herewith gives curves taken from tests made with motors of this character at the Westinghouse shops, Pittsburg, Pa.; this engraving, as well as Fig. 2, were used by Mr. Lamme in illustrating the paper referred to, and we are indebted to the American Institute for the use of these engravings.

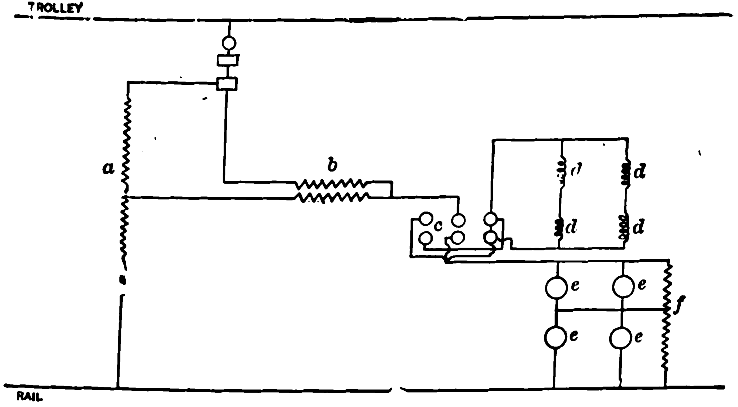

FIG. 2.—DIAGRAM OF CONNECTIONS.

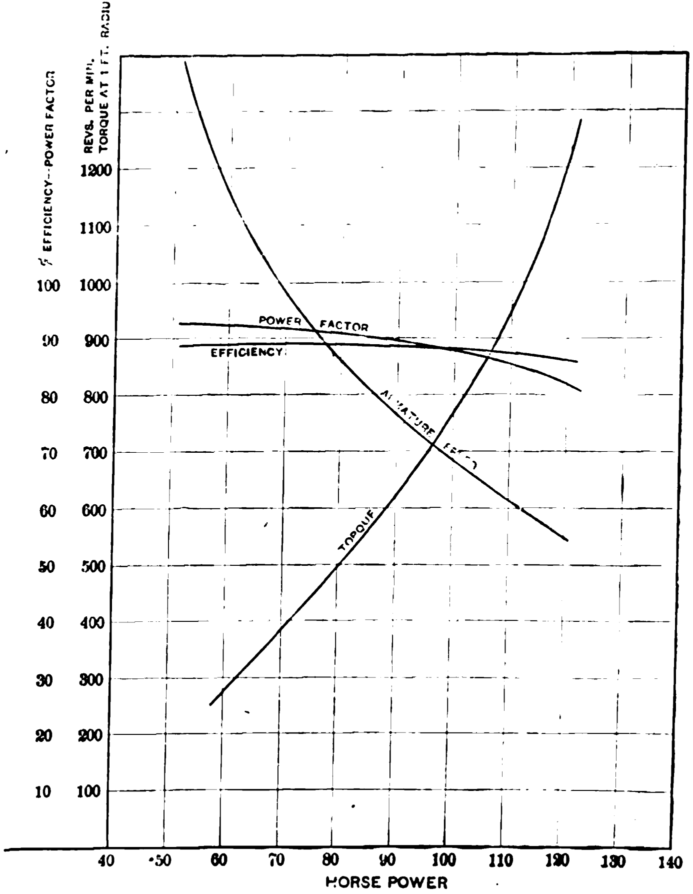

FIG. 3.—MOTOR CURVES.

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Changes in advertisements should reach the office of the American Electrician by the 15th of each month in order to appear in the following issue. New advertisements can be received up to the 25th of each month.

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Means of Attracting New Customers.

The problem of increasing the list of private customers is one that has caused many a central station manager to pass sleepless nights, and the discussion of this subject at the last electric light convention brought out several useful points that were evidently the fruit of some such nights of cogitation. A most practical and complete policy was outlined very concisely by Mr. Charles H. Peters, who advocated "a perfect service at a reasonable price and the sale of fixtures almost at cost." If requested to criticise this policy, we should say that omission of the word "almost" would remedy its only defect. While a central station is a mercantile establishment to the extent that it sells something with a view to money making, it is not sufficiently similar in character to dry goods and grocery "emporiums" to justify selling merchandise for profit. Moreover, as the policy of supplying fixtures at cost cannot fail to enhance the station's legitimate business of selling electricity, the failure to adopt it would appear to indicate rather poor judgment in the plant management.

We do not favor catch-penny schemes, particularly that of giving a prospective customer several months' service free as a bait, even if it were a practical method, and it is distinctly impractical in a properly conducted plant. In order to do this, the wiring and lamps must be installed at the company's expense, and after that has been done it is a simple matter for a "sharp" customer either to drive a pretty hard bargain or to make the company remove the equipment at a loss of from 30 per cent. to 50 per cent. of its original cost, irrespective of any preliminary agreement. A lawsuit over the violation of such an agreement would be absurd and unprofitable. Even when the customer is not of the class named, the policy under discussion is objectionable in that it tends to cheapen the service in the eyes of the public; anything that cannot be sold strictly on its own merit does not stand high. If the prospective customer could be induced to pay for the wiring and the service, an offer to lend the lamps, sockets, switches and such fittings for a trial term would not be so bad, although that is not an especially commendable plan.

No: bargain-counter schemes such as the one just cited have no place in the economics of a central station. Mr. Peters' policy, with the "almost" blue-penciled, if we may be pardoned the insistence, is absolutely impregnable. Of course, the word "perfect" must be defined from a practical standpoint. Nothing temporal can be quite perfect, but there is so much room for improvement in the service rendered by some stations that if the obtrusively obvious defects alone were remedied the result would be relatively ideal service. It is not intended to convey the idea that this condition is general or found even in a large majority of plants. In probably the greater number of stations where improvement in the service is conspicuously desirable, it can be effected only through changes in the plant, carefully worked out, and executed, by very capable engineers. It is a fact, however, and one that has been demonstrated in several instances, that electric lighting and power service can be made sufficiently good to prevent any serious complaints from reasonable customers. So Mr. Peters' stipulations, properly construed, are by no means visionary.

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Rates for Municipal Lighting.

It is a matter of common knowledge among central station managers that the prices paid by municipalities for electric street lighting service in most cases do not cover the actual cost of the service to the contracting company. The average steam-driven central station will not produce electrical power for less than 2 cents per hour for each kilowatt delivered to the distributing circuits. This makes the cost for power practically one cent per arc lamp-hour, at the station—that is, including line losses. A lamp burning 9 hours per night and every night in the year will, therefore, require about $33 worth of energy per annum. Add to this the cost of carbons, trimming, globes, lamp repairs and other incidentals, and the prices paid for the service in hundreds of towns where the conditions are even less favorable than here assumed become manifestly absurd.

It is largely because of this state of affairs that commercial lighting is so limited in many large towns and moderate-sized cities. A company supplying 450-watt lamps all night and every night at $75 per annum can make no money on the arc-lighting contract with the municipality; the private lighting business must, therefore, pay a profit not only on the cost of its own supply but on the cost of operating the remainder of the plant. Indeed, in many cases, some of which have come under our own observation, this branch of the service has to make up a deficit in the street lighting branch and pay the dividends besides. It is not at all difficult to see that such a plant can only hope to obtain as private customers those to whom electric lights are advantageous or desirable almost regardless of their cost.

The judicial acumen accredited to Solomon is not necessary to show that the interests of any community would be far better served if the authorities would pay for municipal service on the basis of a fair profit over the actual cost of the service, at the same time compelling the limitation of charges for commercial service to fair profit-bearing figures, than can be the case under the grinding, cheese-paring policy that is so common. It would be somewhat difficult to arrive at an equitable basis of charges at first, but far more complex problems have been solved time and time again. All that is fundamentally necessary in the present case is honesty of purpose on both sides—but that is an "all" of colossal magnitude if not of utopian character.

The Alternating-Current Commutator Motor.

In another column we print a brief outline of the single-phase alternating-current railway system that is about to be installed between Annapolis, Baltimore and Washington, and the principal feature of which is the use of series commutator motors. It will be remembered by many readers that this was one of the earliest forms of alternating-current motor ever used, if not the earliest, and that its abandonment was due to the seemingly uncontrollable fireworks at the brushes. The wide discrepancy between the behavior of such a motor on an alternating-current circuit and that of an ordinary series direct-current motor is due chiefly to the fact that the armature e.m.f. is not in phase with the field magnetism, so that if the e.m.f. happens to be at maximum value when a commutator segment passes a brush, the field magnetism may be near zero, and there is no commutation This can be partly cured by making the field magnet winding extremely self-inductive and the armature coils of the lowest possible inductance, and also using a very low frequency.

The description of the new motor as presented by Mr. B. G. Lamme in a paper read at the last meeting of the American Institute of Electrical Engineers leaves the inference that the course indicated above has been followed in the design of the machine. It is also stated that a great difficulty in this type of machine has been due to a transformer action between the field magnet and a short-circuited armature coil undergoing commutation, and that this difficulty has been overcome, but the means of remedying it is not explained. Whatever the details may be, it is greatly to be hoped that the motor will prove the success in actual practice that the shop tests appear to promise; in which event another instance of reversion to pioneer principles will be added to the list.

As to "Ignis Fatuii."

In a comment on amateur inventors last month (page 435, third column) one of the myriads of typographical imps made us refer to the chasing of *"ignis fatuii."* While those of our readers who are not Latin scholars probably did not notice the error, and those who are, undoubtedly realized that we were trying to say *"ignes fatui,"* we wish to go on record as not being in the habit of either using the singular first-personal pronoun to excess or pluralizing a Latin adjective while leaving the noun which it qualifies in the singular. It is extraordinarily easy for a compositor to change an "e" into an "i," and slip in one or two of the latter letter for good measure. It is not so easy, however, to pass over such a misprint several times in successive proof readings, but the explanation of this blindness on our part would constitute the solution of a psychological problem far beyond our ability.

The Hours of Station Firemen.

A brief discussion of the question of shortening the working hours of central station firemen with a view to increasing the efficiency of the men will be found on another page of this number. The brevity of the discussion is but natural: the subject does not admit of a great deal of argument. It is axiomatic that the number of working hours per day of any class of men whose occupation involves the expenditure of both muscular and brain power should be made as small as practical conditions will allow; and it cannot be denied truthfully that a really efficient fireman must supplement his brawn with no small degree of judgment. In the case of twenty-four-hour-operation, the experience of the present writer has been that three "shifts" of men, worked so that their "tricks" overlap by at least one hour and at most two, give the best results in lighting stations.

In the cases alluded to, the regular working hours overlapped by one hour, and when unusual work around the fire-room required it, an extra hour of overlap time, on extra pay, was put in by the man or men whose "trick" was expiring. By means of this arrangement the boiler room expense for outside labor, common and expert, was kept down to a trifling figure. The "tricks" were not of equal length; the men on duty during the most important part of the daily run were given the shortest hours—from 4:30 p. m. to midnight; the "trick" involving the least responsibility was made the longest; from 11 p. m. to 9:30 a. m. The remaining "trick" was, of course, from 8:30 a. m. to 5:30 p. m.

Coming back to the original question, it is evident that the highest efficiency will not be obtained unless the highest practical wages are paid judiciously; an intelligent fireman cannot be retained long on the stipend of a ditch digger.

The Rotary Converter.

For those to whom the internal performance of the rotary converter is an attractive but mysterious subject, the article by Mr. McAllister, which appears in this issue, should prove particularly interesting. Appropriating the Irishman's comment on the electric car, the rotary converter is a very "paycoolyar bur-rd," and an adequate idea of what goes on inside of it is not readily acquired from the usual text book treatment of the subject. Students having a fair working knowledge of algebra and plane geometry will find not the least difficulty in digesting the article, and even those who either have not the mathematical ability or lack the inclination to follow through the exposition will find the tables of considerable value and entirely intelligible. In fact, they constitute an excellent summary of all the knowledge that is applicable to every-day working with this type of machine, beyond the mere mechanical routine and the most elementary principles. The latter are presented in plain English, so that the article has the rather unusual feature of combining elementary and advanced treatment, and that, too, without drawing a particularly sharp line between the two.

A feature that may appear unconventional to a beginner in alternating-current study is the application of the term "two-phase" to machines of the type commonly known as single-phase, and the characterization of quarter-phase machines as "four-phase." The reason for this is purely mathematical, and will be clear upon a careful study of the article. This classification of the two-wire and four-wire machines has been used by other writers for the same reason.

CONSTRUCTION OF WIRELESS TELEGRAPH APPARATUS.

The Morse Sounder.

BY WM. A. DEL MAR.

Any telegraph sounder will do for wireless telegraph work, but it is better to have one with moving parts possessing considerable inertia. Such a sounder is here described and shown complete in Fig. 1. It consists of an electromagnet, *A c*, an armature, *b*, a lever, *d*, and various attachments for holding and controlling the motion of this lever. The core of the electromagnet consists of two soft-iron rods, *c*, and a cross piece, *A*. These rods, as shown in Fig. 2, are threaded for half an inch of their length; the threaded ends fit into tapped holes, *a a*, in the bar *A*, Fig. 3. There are also two small holes (not shown), which fit this bar to be secured by countersunk screws to the brass base plate. The armature, *b*, Fig. 4, is made of a piece of soft sheet-iron, bent around a mandrel. It has two 1-16-inch holes, each ⅛ inch from the center, through which are passed screws to fasten the armature to the lever *d*. When finished according to the illustrations, the four parts, *A*, *b*, and *c*, *c*, should be thoroughly cleaned by sand-papering and immersion in acid, and then copper-plated.

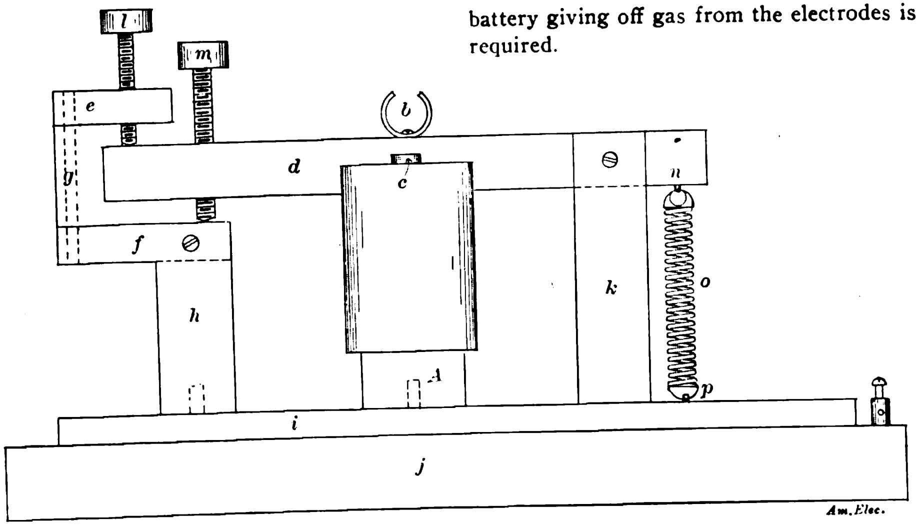


FIG. 1.—TELEGRAPH SOUNDER.

The plating bath is first prepared according to the following formula. Dissolve ¼ oz. of copper sulphate in half a pint of water and add ammonia until the first formed precipitate re-dissolves, forming a deep blue solution. Then add cyanide of potassium until the blue color disappears. A strong battery giving off gas from the electrodes is required.

The iron to be plated is suspended in the bath by thin wires, and connected to the zinc electrode of the battery. The positive terminal of the battery is connected by a copper wire to a plate of copper suspended in the bath. This plate should be bent into a cylindrical form, so as to surround the objects being plated. Care should be taken to avoid inhaling the gas from the cyanide of potassium, as it is extremely poisonous. When a good coating has been put on, the objects are to be removed from the bath, washed and dried.

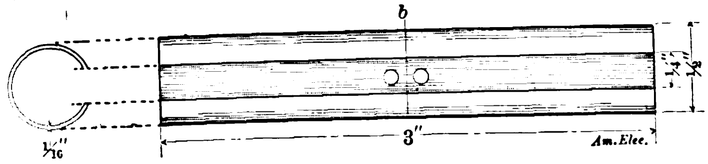


FIG. 4.

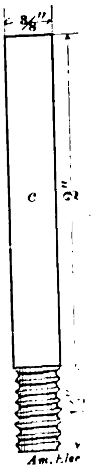


FIG. 2.

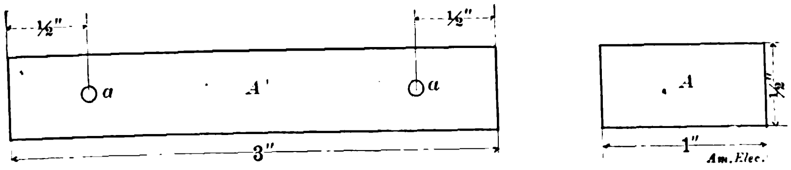


FIG. 3.

The lever *d*, Fig. 5 is then prepared. It is made of square section brass rod. At the center two ¹/₁₆-inch holes must be drilled side by side and ¼ inch apart, to correspond with the holes in the armature, *b*, and must be tapped to receive the screws that are to hold the armature on. One inch from each end a ⅛-inch hole must be drilled all the way through, but at right angles to each other. The hole near the left-hand end, Fig. 5, must be tapped to receive the adjusting screw, *m*, Fig. 1.

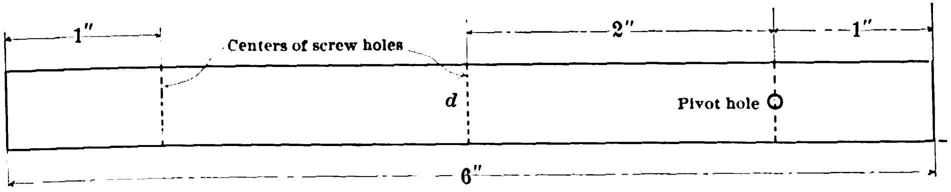
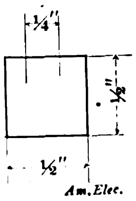


FIG. 5.



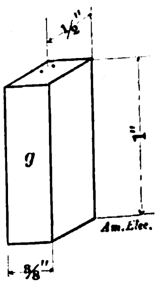


FIG. 6b.

The brass blocks, *f* and *e*, are made as shown in Fig. 6 and 6*a*, and have two ⅛-inch holes drilled at points ³/₁₆-inch from the two adjacent edges, as indicated by the dots. The brass block, *g* (Fig. 6*b*), also has ⅛-inch holes drilled ³/₁₆-inch from adjacent edges, but in this block the holes are drilled lengthwise of the block and are only ¼-inch deep. These holes must be drilled in each end, and must correspond to the holes in *e* and *f*, respectively. The four holes in the block *g* are tapped, and the three blocks screwed together, as shown in Fig. 1. The block *f* has a ⅛-inch hole (indicated by the small circle) drilled through it ⅜-inch from the end opposite the other holes, and at right angles to these latter. This is to pin it to the block *h*, Figs. 1 and 7. The center of the lower end of *h* also has a couple of tapped ⅛-inch holes; the same is true of the block *k*, Fig. 7*a*. At the points *Y*, in the pieces, *h* and *k*, are ⅛-inch holes extending through both upright limbs.

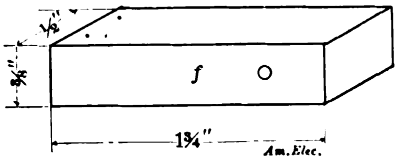


FIG. 6.

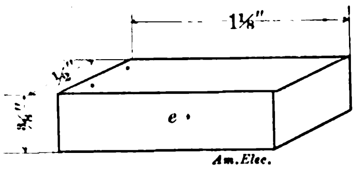


FIG. 6*a*.

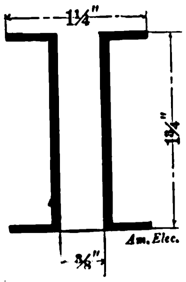


FIG. 9.

Fig. 8 shows the brass base plate. The dotted lines indicate the location of the parts *h*, *a*, *k*, and *p*. Holes are drilled on these lines through the plate, so as to correspond with the holes in *h*, *a* and *k*, when these are centered on the base. A small hole is drilled through the plate at each corner to hold small countersunk brass screws, which serve to fasten it to the wooden base. The heads of the screws which fasten *h*, *a*, and *k* to the plate, fit into holes cut in the wooden base for that purpose.

The coil spring, *o*, Fig. 1, is made of stiff brass wire, and must be just strong enough to lift the lever promptly and sharply. The tension is adjustable by shortening or lengthening the spring. It is connected to the lever and brass base by means of the hooks, *n* and *p*. The screws, *l* and *m*, are of brass, ⅛-inch in diameter.

Before putting the lever in place, it is necessary to put the winding on the electro-magnet. This is composed of No. 24 double cotton-covered copper wire, tightly wound on a brass bobbin of the form shown in Fig. 9. The bobbin is made of two brass washers and a brass tube, the washers being soldered to the ends of the tube. In order to prevent the wire from touching the brass, the bobbin must be well-insulated with paper. The two terminals of the complete winding are brought out to binding posts in the wooden base. The connection between the two coils of wire must be such that one pole of the magnet will be "north" and the other "south" when current is passed through the coils from a battery of two or three cells. The coils are to be connected in series. The wooden base is shown in Fig. 10. It may be beaded or otherwise ornamented in any simple way that the maker chooses.

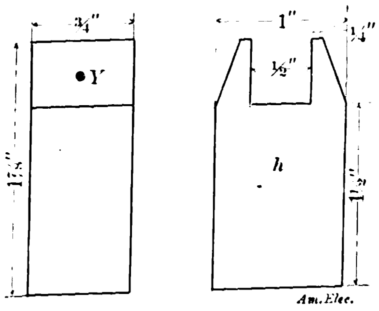


FIG. 7.

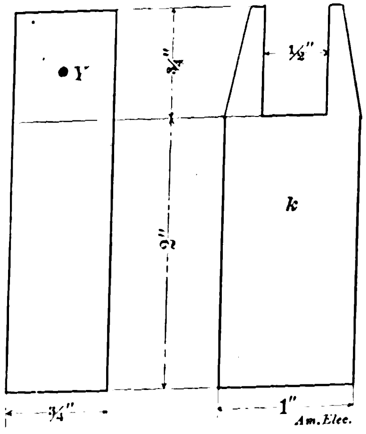


FIG. 7a.

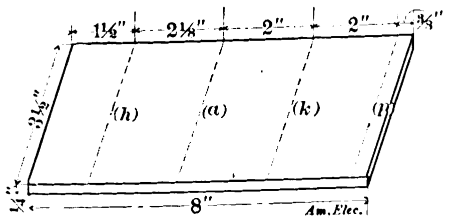


FIG. 8.

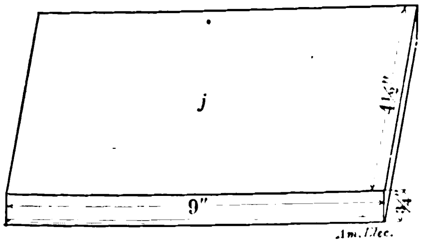


FIG. 10.

STOKING IN CENTRAL STATIONS.

The question of hand stoking *vs.* mechanical stoking was discussed at the recent Electric Light Convention by only two of the delegates present, Messrs. E. J. Bechtel, of Toledo, and W. L. Abbott, of the Chicago Edison Company. Mr. Bechtel said that his company had previously used hand-fired furnaces supposed to be of the smokeless type, but was at the time of the convention engaged in installing chain-grate stokers under all of the boilers in the station. The company has found them more efficient, and that they can get more capacity from the boilers without any greater strain, presumably on account of the heat in the furnace being constant.

The fire is perhaps not so sensitive to sudden changes of load, but it has been found sensitive enough to meet all conditions. With these stokers there was less unconsumed carbon in the ash than with hand firing, and much less smoke. It is not possible to use this form of stoker with all grades of coal, but the company finds it desirable with all coal obtainable in Toledo.

Mr. Abbott pointed out that the conditions which determine the preferability of hand or mechanical stoking are very varied; that in deciding the question for any one case the difference in cost of labor, difference in fixed charges, difference in efficiency and price of fuel, as well as labor troubles and smoke nuisance, should be considered. As an illustration he assumed the case of a boiler plant of four boilers running ten hours a day, three hundred days a year, and burning one ton of coal an hour each, which amount of coal could be fired by hand at a cost of 20 cents per ton; also, that to equip each of these boilers with a stoker would cost $2,500 more than a plain grate, and that the fixed charges would be 5 per cent for interest, 8 per cent for depreciation, and 5 per cent for repairs—a total of 18 per cent. This for each stoker amounts to $450 per annum, or $1.50 per day for 300 days, and in burning ten tons of coal a day the expense for fixed charges would be 15 cents per ton. If one man at 20 cents per hour will attend four stokers, the cost for labor and fixed charges will be 20 cents per ton, or just equal to the cost of hand firing. He, therefore, concluded that under the conditions assumed the preference as regards labor and fixed charges lies with the one system or the other depending upon whether the amount of coal burned is greater or less than forty tons a day.

If coal cost $1 a ton, and if mechanical stoking is 10 per cent more efficient than hand stoking, then in a plant of two boilers, burning ten tons each, the cost per ton for the two systems would be:

Mechanical Stoking.		Hand Stoking.	
Labor	.10	Labor	.20
Fixed charges ...	.15	Fuel wasted	.10
Total	.25	Total	.30

If coal costs $2 a ton, the relative costs with one boiler would be:

Mechanical Stoking.		Hand Stoking.	
Labor	.20	Labor	.20
Fixed charges ...	.15	Fuel wasted	.20
Total	.35	Total	.40

This indicates that under the assumed conditions of fixed charges, labor and economy, and running ten hours a day, mechanical stokers are preferable when they are 10 per cent more efficient than hand firing, if coal costs one dollar a ton and twenty tons a day are burned, or if coal costs two dollars a ton and only ten tons are burned. In the same way other figures might be deduced by assuming that stokers are in use more or less ten hours a day, and that the difference in economy is more or less than 10 per cent.

Aside from the possibility of saving money, there are often other considerations which enter into the case. A boiler room employing a large amount of ignorant labor is an attractive proposition for the labor agitator. Moreover, it is impossible in such a boiler room to prevent smoke when bituminous coal is being fired by hand. It is, however, possible to install automatic stokers which will neither strike nor smoke.

The question: "Is it desirable to shorten the hours of firemen to increase their efficiency?" was discussed by more delegates, but not quite so extensively as the preceding question. Mr. R. J. Patterson, of Waterville, Me., said that in large plants an eight-hour shift of firemen is good practice, but in smaller plants, where there are two shifts, of course the added expense of another man or set of men generally means much more expense with no better results, so far as firing is concerned. It is sometimes beneficial in such cases to have two ten-hour shifts and one four-hour shift; then two firemen are in the room together for six hours a day, giving opportunity for doing much work that could not otherwise be properly attended to. Mr. E. J. Bechtel, of Toledo, expressed the opinion that it is advisable to work firemen on hand firing furnaces eight hours in preference to twelve, especially in summer time, as so much depends upon the fireman's condition and disposition. His company had made this change, but he could give no figures to verify his opinions; the work of the firemen, as well as the condition of their fires, however, speak well for the system.

Mr. Abbott, of the Chicago Edison Company, declared that the expense of a fireman lies more in the cost of the fuel that he wastes than in the wages which he receives. A fireman doing an ordinary day's work will burn, say, 8 tons of coal worth $2 per ton, amounting to $16; for this work he will be paid $2 a day. The boiler efficiency in an ordinary hand-fired plant does not average over 50 per cent, whereas on test conditions, the same fireman will sometimes get an efficiency as high as 75 per cent, and this economy, if it could be maintained, would amount to $5.33 a day. It is not to be expected that the very best results will be obtained day in and day out, but if the fireman were given less work to do, shorter hours, and a rest in the middle of his "shift," his work would be materially improved; and while it might be necessary to add one or two men to the pay-roll in some cases, the saving from the coal account would more than offset this additional expense.

THE ENCLOSED ARC LAMP.

BY RALPH SCOTT.

It is not the purpose of this article to elaborate on what has already been said regarding the enclosed arc, but merely to sum up in a general way, for the convenience of the average reader, the good points and principles of this type of lamp.

In the ordinary open-arc lamp the carbons burn or waste away so rapidly that for a single night's illumination (with the series street lamp) two sets of carbons are required. Hence the advantage of the enclosed lamp, in which a single set of carbons burns from 150 to 200 hours. In order to accomplish this it is merely necessary to enclose the carbons, or at least the arc, in a glass globe, so that the outside air will have no chance to act on the carbon at the arc. If this be done with a series lamp, however, it will be found that the light given off is greatly decreased, the reason for which will be explained later. If all the air be excluded from the arc, it will be found that the disengaged particles of carbon will float around in the globe and finally deposit themselves upon the sides and bottom of the globe and in a short time shut off a great deal of light from the arc. It is therefore obvious that a little air is necessary to circulate in the globe or bulb, so that this uncombined carbon may be oxidized. Moreover, if the globe were made perfectly air-tight the expanding gases would cause an explosion. The combination of the carbon and the air forms carbon dioxide, which is harmless so far as blackening the globe is concerned.

In order to obtain this limited supply of air, a small opening should be left in the globe or above it, through which a small quantity of air may find admission. This may be accomplished by leaving a small air space between the upper carbon and the cap into which it slides. On no account must an opening be left in the bottom of the inner globe, since the globe will then act as a chimney and the carbons will be consumed much faster. It is therefore important to have no nicks or cracks in the bottom of the inner globe.

Even when a little oxygen or air is admitted to the globe a small quantity of silicon and calcium, which are found in even the purest carbons, will form on the inside of the globe and shut off a little light, but in some cases this seems to improve the color of the light. This deposit may be readily washed out by dilute hydrochloric acid every few months, and will not be found to give much trouble. Sometimes this acid seems to attack or affect the glass in such a way as to greatly increase its liability to crack by uneven heating; therefore, it should only be used when absolutely necessary.

In the open arc, if the upper carbon be raised so as to increase the potential across the arc to 80 volts, it will be found that a flaming, hissing and very wide arc is the result, and the carbons will waste away very rapidly owing to the free access of the oxygen of the air to the arc, which now gives off a great amount of heat, but very little light. If the arc were enclosed the action would become entirely different, the arc assuming a quiet, non-hissing, non-flaming condition, because of the greater number of uncombined carbon molecules; and, being more compact and offering more resistance, the arc gives much more light and less heat. The light produced by an enclosed arc is due chiefly to the incandescence of the carbon vapor, while in the open arc the light given off is produced chiefly by the incandescent carbon tips, which are heated by the combustion of the carbon vapor.

As a higher voltage is required to force current across the longer arc of the enclosed lamp, the e.m.f. may be advantageously increased to 80 volts in a 5-ampere lamp; in fact, it must have this potential across the arc or it will not yield the characteristic results of this type of lamp. All attempts at changing series lamps into multiple enclosed lamps have been failures for this reason. Some lamps may be adjusted to increase the length of the arc sufficiently, but in most types this cannot be done, and an enclosed lamp having only 50 or even 55 volts across the arc is a failure, since it sometimes gives only a little more light than an ordinary candle.

A 3½-ampere enclosed-arc lamp, with 80 volts across the arc, gives about the same effective light as a series lamp using 7 amperes at 45 volts, so that the efficiency is much in favor of the former type. Enclosed lamps are generally connected in multiple across 110 and 220-volt circuits and in series of two and five across 220 and 550-volt mains. The standard 220-volt lamp takes 155 volts across the arc and passes 2½ amperes; the 110-volt lamp takes 80 volts at 5 amperes, the length of the arc in the latter case being about $^{13}/_{32}$ in.

In an enclosed-arc lamp with a shunt coil, the dashpot must be stronger than in the series lamp with a shunt coil, so that the movements of the carbon will not be too sudden or spasmodic. If this provision is not made, the arc will be disrupted or broken, causing the lamp to "wink." In the alternating-current lamp, on account of the low heat of the arc and its tendency to blow itself out, the damping or dashpot action must be very slow, and the moving parts must have considerable weight, which provision is unnecessary in direct-current lamps. The disadvantages of alternating-current arc lamps are singing at the arc and in the mechanism and poor regulation; in later lamps, however, these troubles have been reduced to a considerable extent.

Another point worth consideration is the hissing in arc lamps. This pecularity is seldom observed in an enclosed-arc lamp except at the start while the inner globe is full of air. Hissing is due to several causes, chief among which are the following: The carbon, especially at the crater, is in a state of ebullition; if the current taken by the arc is great, or if the arc be very long, the arc, having so much surplus vaporized carbon, is attacked, especially at its widest position, by the oxygen of the air, resulting in minute explosions or combinations of this carbon oxygen, which occur with such great rapidity as to cause a hissing vibration; if the current used is too great, however, the noise of the arc will then assume a humming or purring character.

In the enclosed type the distinction between the crater and cone is not very marked; in fact, it is almost impossible to tell the difference between the positive and negative carbon tips, both having a rounded appearance. At the moment when the current is shut off from the lamp, it will be noticed that the positive carbon tip is the hotter, or stays red the longer, which is the test applied to determine whether the lamp is connected correctly or not. When taken out, the carbon tips possess a smooth, perhaps polished, appearance, and are generally cracked. The carbons should never be rough, as this indicates that too much air gets into the inner globe.

The carbon tips from the non-hissing open arc possess the following properties: The cone is tapered to an angle of about 70 degrees, and has a small knob of carbon deposit at its end; the crater is uniformly hollowed out and covers the greater part of the end of the positive carbon, and there are no fringes on either tip. If the tips do not show these characteristics, then it may be assumed that the arc has been hissing or has been passing too much current.

A curious effect in an arc-lamp circuit is the following: Upon opening the circuit there is seldom more than a very small arc at the switch. The reason for this is that any arc, however small, quickly introduced in series with a lamp will immediately break the circuit. For this reason a considerable number of arc lamps will give no more spark at the switch break than an equal number of incandescent lamps. Hence, the switch will not have to stand a very heavy arc on opening the circuit. By reason of this feature, considerable economy may be effected by using snap switches for this purpose, this type of switch having a longer life than others.

The following rules should be observed by those who have any arc lamps under their charge or attention:

1. Always have the top carbon positive, that is, hottest.
2. Never allow the dashpots to stick.
3. See that the upper carbon does not bind.
4. See that the clutch works reliably and smoothly.
5. Throw all cracked, "run" or nicked inner globes away.
6. Keep all contacts tight.
7. Use no undersized or crooked carbons.
8. Keep asbestos washers in perfect condition.
9. Always have strong supports for suspending the lamps.
10. Do not allow resistance wires or coils to sag.

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Long-Range Dynamos.—A recent issue of the Chicago *Tribune* contained an advertisement offering for sale "two first-class Royal Electric Company dynamos of 150 kilometers each, with fittings."

LUBRICATING GREASE AND GRAPHITE CUPS.

BY JAMES F. HOBART.

A class of cylinder-oiling cup is largely used in which the lubricant is either grease or a mixture of grease and graphite, and is fed by means of a screw, the entire contents of the cup being under compression. This device is known as the compression grease cup, and is made in several forms, differing usually in details rather than in fundamental principle. Fig. 1 represents the Stover cup, made by M. E. Stover, Saginaw, Mich. This cup has double walls, *A, B,* within which is a piston *F,* mounted on a screw *E.* The screw is permanently attached to the cap, *C,* of the cup, which is secured to the outer shell, *B.* This shell is revolvable, and is geared to a ratchet wheel *M,* through a worm. The ratchet wheel is turned by a reciprocating arm and pawl, from some part of the engine. The amount of grease fed into the cylinder at each stroke depends upon the amount of travel given to the rod which imparts movement to ratchet *M.* The lugs, *f, f,* are for preventing the compression head, *F,* to which they are attached, from turning around with the screw instead of traveling straight down within the inner cylinder.

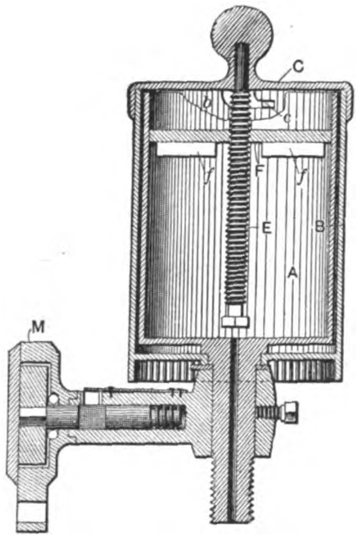

FIG. 1.—STOVER GREASE CUP.

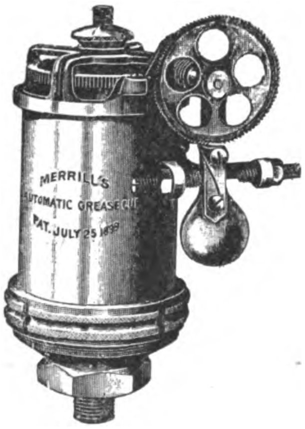

FIG. 2.—MERRILL GREASE CUP.

Fig. 2 illustrates the Merrill automatic grease cup in which the compression screw is actuated by the inertia of a pendulum. The upper end of the pendulum lever carries a pawl which engages the rim of the ratchet wheel immediately above it; the spindle of this ratchet wheel is geared to the compression screw in the center of the cup by means of a worm-gear. It is obvious that the swinging of the pendulum will effect the gradual turning of the compression screw and thereby feed the grease; it is also evident that this cup must be used to lubricate some reciprocating part of an engine or pump, such as a crank-pin or cross-head pin, as the pendulum requires this character of motion for its operation. This cup is manufactured by James L. Robertson & Sons Company, New York.

Among the many simple compression cups devoid of automatic features that have come into wide use are those illustrated by Figs. 3 to 6, inclusive. The cup illustrated by Fig. 3 is the "Simplex, and is manufactured by the Penberthy Injector Company, Detroit. It has a rubber piston, and for filling the entire internal part of the cup is unscrewed and removed from the base, thus permitting the body of the cup to be made solid and forever free from leakage. Fig. 4 shows another Penberthy cup. This one has a screw-cock form of valve in the shank, by means of which the rate of feed may be adjusted. Another feature is a tension spring around the screw spindle, which holds the screw in any desired position.

The cup illustrated by Fig. 5 seems to possess about all the features that can be given to a compression grease cup. It is a Lunkenheimer production, known as the Vulcan, and has a lock nut on the compression screw, a packed piston, a feed-regulating cock in the shank, and a bull's-eye sight glass.

Fig. 6 shows a compression cup in which the spring is designed to give uniform pressure from beginning to end of the travel. This is secured by means of the double-taper spring, which makes the pressure very nearly uniform. The piston of this cup is faced with leather, and when the plunger is drawn up for filling the cup, air enters through the holes in the leather, permitting the piston to move easily, and preventing the disturbance of the grease in the bottom of the cup.

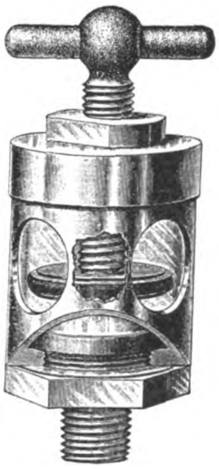

FIG. 3.

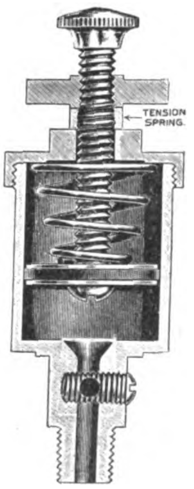

FIG. 4.

Fig. 7 shows a simple grease cup for journal bearings, manufactured by M. Brousard & Co., of Chicago. It consists of a simple brass cup with a shank threaded in the usual manner for insertion in the top of a bearing, the body of the copy containing a heavy piston, which is marked "weight" in the engraving. Through the center of the cup is a metal pin mounted loosely in the cap and adapted to rest at its lower end directly on the revolving shaft. Any increase in the temperature of the shaft causes the pin to become warm and soften the grease at the lower part of the cap; the heavy piston on top of the mass of grease is thus enabled to feed the softened lubricant to the bearing. A wire loop attached to the piston and projecting through the cap serves to indicate the position of the piston.

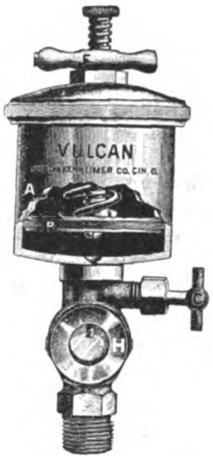

FIG. 5.

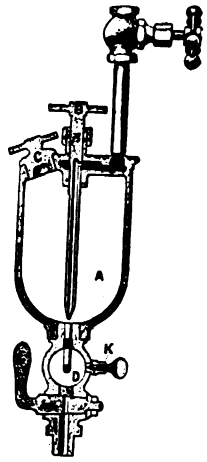

FIG. 8.

Fig. 8 illustrates a very complete graphite feeding cup manufactured by the Lunkenheimer Company, Cincinnati, Ohio. The central spindle, *B,* is hollow, and the canal in its center communicates with a cavity in the top of the cup through a small hole in the side of the spindle. Live steam is delivered to this cavity from the engine steam pipe or any convenient source, and serves to blow the graphite through the sight-feed chamber, *D,* into the delivery shank. The force of the steam jet is adjustable by screwing the spindle, *B,* up or down, and the rate of feed is adjustable in the usual manner by means of the cock

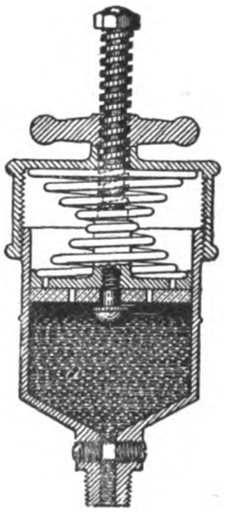

FIG. 6.

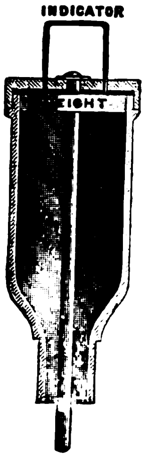

FIG. 7.

E. This cup is used for cylinder lubrication and is preferably attached, like any other cylinder lubricator, above the engine throttle, although it may be attached below the throttle or directly to the steam chest, provided the pipe for the steam blast is connected to the main steam pipe above the throttle.

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A FEW HINTS AS TO THE INSTALLATION AND OPERATION OF ALTERNATORS IN PARALLEL.

BY FRED P. WOODBURY.

Since the introduction of the polyphase system of distribution, the field of the alternating-current generator has been so greatly enlarged that the subject of this article is one of very general interest at this time. There are two types of alternating-current generators—high-speed machines, designed to be belt-driven, and low-speed machines designed to be directly connected to an engine either by a coupling or by placing the revolving member directly upon the engine shaft. These types are divided into two classes: The separately-excited machine, which receives all its field excitation from an outside source, and the composite-wound machine, which has a second winding upon the field magnets that serves the same purpose as the series winding on the direct-current generator.

As alternating currents are usually generated at a much higher voltage than direct currents, the location of the machine requires more consideration and the care of it is proportionately greater.

The machine should be installed in a well ventilated room, where it can be kept clean and dry and free from oil and dust, particularly from coal dust. It should set upon a firm foundation so that there will be no vibration when running. Some engineers prefer to ground the generator frame, others to insulate it, and still others to ground it through a very high resistance. The object of this last plan is to gain the advantages as far as possible of the insulated frame, and at the same time provide a path to ground for static discharges. In any case there should be an insulated flooring about the machine, so arranged that the attendant must stand upon it when touching any part of the machine.

In setting up a belt-driven machine, its base should rest on a heavy hardwood frame, its shaft should be absolutely parallel to the driving shaft and the crowns of the driver and driven pulleys exactly in line. The distance between the centres of the shafts should not be less than 2½ times the diameter of the largest pulley. The belt should run with and not against the lapping, and if possible it should be arranged so that the slack side will be on the top. The belt should have just sufficient tension to carry the load without slipping—no more. The "wabbling" of a belt is sometimes due to too great tension or unlike crowns on the pulleys. A slippery spot on one pulley will sometimes cause violent flapping.

When installing a machine having bearings separate from the field frame, the armature and bearings must be located first and then the two halves of the field slid up to it on each side. If difficulty is experienced in sliding the castings, cut the heads off of some large wire nails and use the shanks as rollers.

Great care should be taken in centering the armature in the field and adjusting the air-gap between the armature iron and the pole-faces, as any inequality will cause the armature to pull towards one side or the other, and is likely to heat the bearings. The air-gap should be gauged at several points at both ends of the armature. This may be accomplished by inserting a wooden wedge between the armature iron and the pole-face and noting the distance the wedge enters. Some engineers purposely set the armature nearer the upper pole-faces in order that the magnetism may take some of the armature's weight off the bearings, and to allow a margin for wear in the bearings.

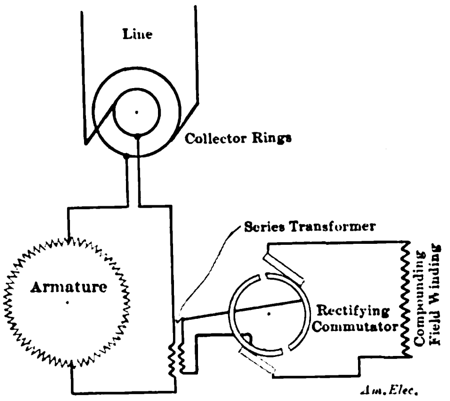

FIG. I.

It is advisable to try the polarity of the fields (which should be alternately north and south) before starting the machine, as follows: Balance a piece of steel wire about three inches long by tying a thread tightly around its center. Magnetize it by laying it across adjacent pole tips, and sending a strong current through the field coils. Pull the wire away by the thread and carry it slowly around the field yoke just far enough from the pole tips to prevent its touching them. The wire will present alternate ends to the magnets if the polarity is correct, but if two adjacent poles are found of the same polarity the wire will not reverse. This method of testing polarity is preferable to using a compass as the action of the wire is very decided at all times. It is desirable to mark one end of the wire in order to follow its motion more easily.

When the machine is fully installed the bearings should be filled with oil, and it should be run slowly for several hours to see that everything is working properly. Care should always be taken when starting a machine to see that the bearings receive sufficient lubrication. If the machine has been packed for some time the insulation may be damp and should be thoroughly dried out before it is subjected to the full voltage. A good way to accomplish this is to run the machine with the armature short-circuited through an ammeter, and excite the field sufficiently to cause full load current to flow in the armature coils. About ⅙ the normal field current will be required to do this.

Most of the smaller revolving armature generators are composite wound that the machine may automatically hold up its voltage as the load comes on. Some types of machine accomplish this compounding by sending the armature current through a series winding on the field after "rectifying" it, but by far the best method is to use the series transformer because then it is only necessary to commutate a low-voltage current in "rectifying" it for field excitation. The series transformer is merely two coils of wire of a few turns each wound on the armature spider. Fig. 1 shows the armature and composite field connections of a single-phase alternator of this type.

Two alternators may be run in parallel when their voltages and frequencies are equal, but they must, of course, be in phase or synchronism when the connecting switch is closed. To ascertain the phase relation of machines to be thrown in parallel, synchronizing lamps are commonly used. Fig. 2 shows the connection of armatures and synchronizing lamps for paralleling two low-voltage single-phase alternators, in which *A* and *B* represent the armatures of the machines; *C* and *D*, double-pole switches, and *L L* the synchronizing lamps. When the switch *C* is closed the voltage of *A* is thrown on the bus-bars and the lights begin to come and go, showing the lack of synchronism between the machines. When the machines are in phase there will be no difference of potential across the jaws of the switch *D*, and, therefore, the lamps will be dark and the switch may be closed.

While the foregoing method is satisfactory for low voltages, it is not safe to use series lamps on high potential machines. Fig. 3 shows the connections of two 2000-volt single-phase alternators with transformers used to reduce the e.m.f. to 100 volts for the synchronizing lamps; *A* and *B* represent the machines, *C* and *D* the main switches, *E* and *F* the transformers, *L* the synchronizing lamps, and *P, P,* pilot lamps. Great care must be taken to get the transformer connections right, otherwise the lamps may burn brightly when the machines are in phase and be dark when in opposition, in which case a serious accident would occur if the machines were thrown together.* For this reason it is desirable to connect the transformer of one machine, say, *A*, temporarily to the bus-bar side of the main switch, as shown in the diagram.

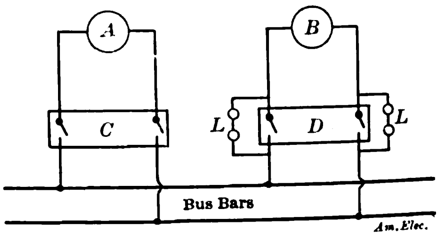

FIG. 2.

Now when both the machines are up to full speed and voltage, if the switch *C* is closed (*D* being open) the synchronizing lamps ought to begin to flicker and the pilot lamps to burn steadily, showing that there are no open circuits in the transformer connections or broken filaments in the lamps. Then the switch *C* is opened and the switch *D* closed, when the same potential will be thrown across the primaries of both transformers and a condition will exist similar to that when the machines are in synchronism. Therefore, the synchronizing lamps should be dark while the pilot lamps burn.* If this is not the case, reverse the primary leads of one transformer and the synchronizing lamps will be dark.

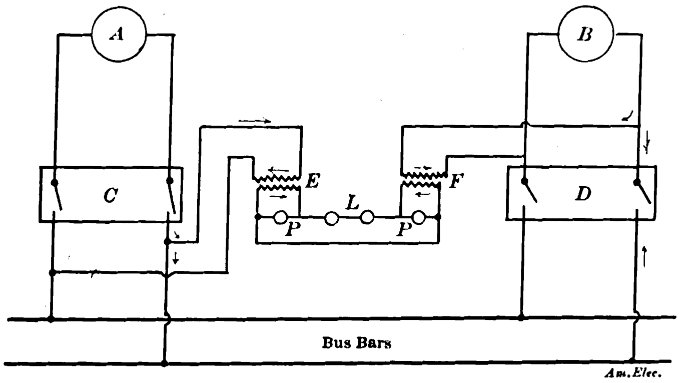

FIG. 3.

Now open the switch *D* and close *C* once more; the synchronizing lamps will begin to flicker, and the switch *D* may be closed without accident when the lamps are dark. Then the lead wires of the transformer *E* should be transferred to the other side of the switch *C,* great care being taken not to reverse them in the process.

Fig. 4 shows connections of transformers and synchronizing lamps sometimes used for starting synchronous motors or rotary converters. With this method of connection, however, it is necessary to have another switch to entirely open the circuit between the two machines, and the transformers are useless for any other purpose but synchronizing.

In connecting two-phase generators for parallel running it is necessary to synchronize both phases the first time the machines are paralleled. After they have once been "phased up," synchronizing one phase is sufficient. Fig. 5 shows the connections for properly "phasing up" two, two-phase, generators, where *A* and *B* represent the generators; *C* and *D,* the four-pole main switches; *E, F, G, H,* the transformers and *L, L',* the synchronizing lamps. When the machines are running at full speed and voltage, if the switch *C* be closed the lamps will begin to flicker, showing there are no open circuits in the apparatus. Then the switch *C* should be opened and *D* closed in order to ascertain if all the transformers are connected correctly.

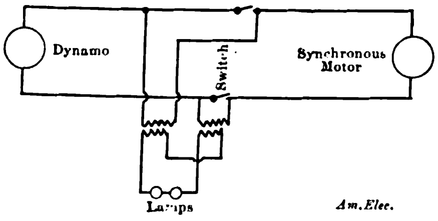

FIG. 4.

Next cross any primary leads that may be necessary to make all the lamps dark; then open the switch *D* and close the switch *C,* and the lamps *L* and *L'* ought to begin to glow in unison, that is, attain maximum brightness at the same instant and die out together. If, however, one phase is bright when the other is growing dark the phases are connected wrong and the lead wires of one phase on one machine should be reversed. It will then be necessary to test out the synchronizing apparatus again as at first. After this is done and all connections made correct, all the lamps will glow in unison and the machines may be thrown together without danger. The synchronizing apparatus may then be removed from one phase, and the leads of the remaining transformer on machine *A* transferred to the other side of the switch *C.*

Fig. 6 shows the connections of synchronizing lamps and transformers for paralleling two three-phase machines. It is only necessary to proceed as in the case of the two-phase machines. If the lights on both phases do not come and go simultaneously when the machines are running at normal voltage, reverse two leads on one machine and try again. The right combination will readily be found. Always test out the connection of the synchronizing converters, as previously explained after each change of the leads upon a machine.

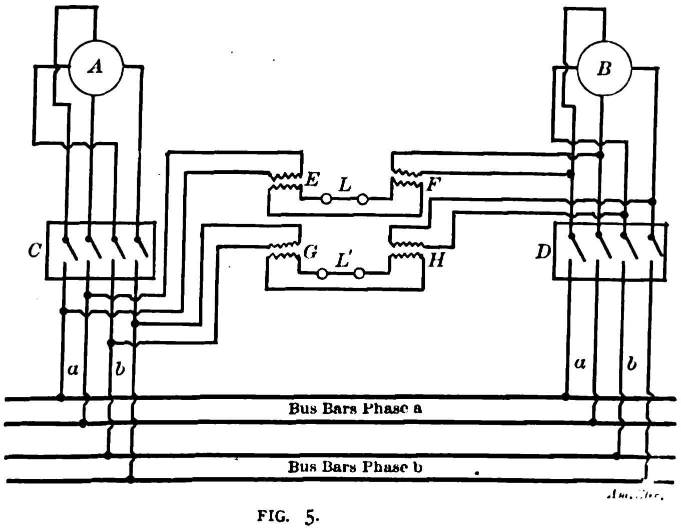

FIG. 5.

It is only necessary to "phase up" two of the phases and the third is bound to be right. After the machines have once been paralleled and the leads connected permanently to the switchboard, synchronizing one phase is sufficient, as in the case of the two-phase machine.

It is sometimes impossible to bring out leads from the winding of an armature and have the number of turns in all sectors equal. Thus, suppose an armature for a two-phase machine had 174 turns on it; then taps for one phase would be brought out at the beginning of the 1st and end of the 87th turn, and at the end of the 43d and 130th turns for the other phase; therefore, though the voltages of the phases would be equal, the side circuits would be slightly out of balance, their turns being respectively, 43, 44, 43, 44. It is highly desirable to connect the high sectors in parallel, otherwise a wattless or idle current will always flow between the armatures. The voltages of the main and side circuits should be carefully measured before the machines are paralleled.

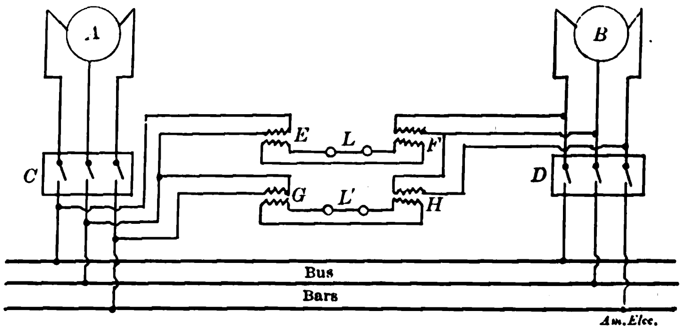

FIG. 6.

Generally speaking, if similar armature leads are connected to the same bus-bar the phases will match all right. The above applies to three-phase as well as two-phase armatures.

In connecting composite-wound alternators for parallel running their compensators should be connected in parallel also. Care must be taken to connect the positive brushes together and the negative brushes together, for otherwise the two series converters will short circuit each other and the field coils will get no current.

The current in the compensator of a machine, though direct, is pulsating. The main circuits of two polyphase alternators may be in parallel, yet the pulsations of the compensators out of step. That is, their maximum e.m.f.'s do not occur at the same instant, in which case the one of low potential would form a short circuit upon the other one, and again the field coil would receive but little current.

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* The author evidently has in mind the arrangement where complete darkness indicates synchronism. The opposite arrangement is sometimes used.—Editor.

To determine these points in two-phase machines they should first be run separately under load to ascertain if the compensators are working properly. Then the compensator brushes should be short-circuited with a piece of heavy wire, or by pushing one brush forward the width of one segment of the commutator, when the line voltage will drop somewhat if the compensator is connected right. If the e.m.f. does not drop off, then the compensator will be found to be either working in the wrong direction or short-circuited. Now shut down the machine and set the brushes so one set comes on an odd segment and the other on an even segment. That is, set the brushes on either segments 1 and 2, or 1 and 4, etc. Then start the machine and put on a load. The compensator current will either magnetize the field and raise the line voltage, or demagnetize the field and cut down the voltage, according to its direction around the field coils. Now rock the brush holder one segment, and thus reverse the current in the field coils. If the line voltage drops off, the first position was correct, if it rises, the second is right. When both machines compound properly when separate, parallel their main circuits, and run leads from the compensator brushes of one machine to the other. When connected one way the line voltage will probably drop off, suddenly showing that the compensators are short circuiting through each other. When the leads are reversed the line voltage will be constant or rise slightly. If, however, the reversal of the leads makes very little difference in the line voltage and the machines do not compound properly, then the pulsations in the compensators are not in step and it will be necessary to exchange the phases of one machine. That is, if phases *A* and *B* of one machine are connected to phases *A'* and *B'* of the other respectively, then phase *A* of one machine should be connected to phase B' of the other, and phase B to phase A' of the other.

Three-phase machines should be treated the same as two-phase machines. If the compensators appear to be out of step, shift the connections of the main circuits of one machine until the proper combination is found.

The load on alternators running in multiple cannot be manipulated by varying the field strength, as in the case of the direct-current machine, but is dependent upon the prime mover. If a machine is not taking sufficient load the power of the engine or waterwheel driving it must be increased so that the machine will tend to speed up and take load from the other machines in the battery.

The power factor of a circuit, that is, the ratio of the true to the apparent watts, depends on the nature of the load. If the load is largely incandescent lamps or electrochemical baths or furnaces, it will be practically 100 per cent., or unity; if the load is made up of rotary converters, induction motors and the like, the power factor will be less than unity.

The voltage at the terminals of all machines running in parallel must be equal; if the field strength of one of the machines in a battery is greater than that necessary to maintain its voltage under the load it is carrying, if it were running independently, then a lagging current will flow in the armature sufficient to demagnetize the fields enough to produce a terminal voltage equal to that of the other machines in the battery; conversely, if the field excitation is not sufficient to produce a voltage equal to that of the other machines in the battery, then a leading current will flow in the armature, thus raising the field magnetism sufficiently to produce the necessary voltage at the terminals. Therefore, it is desirable to properly adjust the field strengths of machines running in parallel, particularly if they are of large size.

Any static charges that occur either on belts or in the high-tension winding of transformers should be carefully grounded or they may find ground themselves by breaking down the insulation of the apparatus. For the protection of transformers a static interrupter is desirable.

The current of air that is constantly drawn through a machine when running deposits a large quantity of dust in the winding. Often this dust contains a large percentage of carbon, and it also furnishes a medium in which moisture may collect and thus reduce the insulation resistance of the machine very materially. For this reason the armature and field coils should be carefully blown out with a jet of compressed air every 10 or 12 days. The air pressure should not exceed 30 pounds to the square inch, otherwise it will blow the dust into the insulation instead of off from it.

The insulation between the conductors and the iron should be tested every time the machine is cleaned. This test should not be very severe; 50 per cent. above the normal voltage of the machine is ample.

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THE FAILURE OF STREET CAR BRAKES.

BY FRANK BERRY, JR.

On of the most important factors in the successful operation of a street railway is the condition of the car brakes. On a road where hand brakes are used, there are generally more cars turned in for bad brakes than for any other cause. Among the most frequent faults in the action of brakes are hard pulling, sliding or skidding of the wheels, kicking, and binding of the brake shoes.

The principal cause of a hard-pulling brake is insufficient leverage. Under certain conditions a car will pull up all right from one platform, while from the other platform the brake may pull very hard. This is usually caused by one end having more leverage than the other, or one pair of shoes being set closer to the wheels than the other pair. Under this condition, setting all the brake shoes at the same distance from the wheels will make the brake pull alike from both ends of the car. If, however, more leverage is required, the equalizer rods must be pulled together at the turn-buckle.

It is well known that when the winding stem has a great deal of leverage the brake shoes will wear the chill off the wheels much quicker than if less leverage were allowed, and when the chill is worn through the wheels very quickly develop flats. It should be borne in mind that a car can ordinarily be pulled up with about one and one-half turns of the brake handle, and the brake rigging should be set correspondingly.

Care should be taken also to make sure that the brake-shoes do not rub against the wheels when the brake-stem is released. This condition can easily be detected by sounding the car wheels with a small hammer. If the wheel rings when it is struck, this is a sure indication that the brake shoe hangs clear, but if no ringing sound is obtained the shoe should be drawn away from the wheel until the latter rings upon being struck.

The sliding or skidding of car wheels is, of course, due to too much leverage, or else to an irregular spacing of the brake shoes. The remedy for excessive leverage is to let out the equalizer rods at the turn-buckle. The remedy for irregular spacing of the brake shoes is obvious.

The kicking or chattering of a brake beam is confined to double-truck cars, and is caused by a flange being formed on the outer side of the brake shoe due to wear; these flanges, when the brake is applied, bind against the outer sides of the car wheels until the brake beam is drawn up against the kicking shoes immediately above it. Regular inspection will, of course, disclose the fact that these flanges are being formed, and as soon as the flange reaches an appreciable height it should be promptly chipped off.

It is also a common occurrence that kicking or chattering by the brake beam is caused by excessive wear, which allows the brake beam to drop below the normal position. In this case the kicking shoes should be lowered slightly. Care should be taken, however, that the kicking shoes are not set too close to the brake beam, as this will interfere with the good braking qualities of the rigging.

The binding of brake shoes against the wheel treads occurs mostly in cold weather, when it is due to the freezing of water thrown on the brake rigging in washing up. A car that is shoe-bound from this cause can easily be put in good condition as to its brake rigging by melting the ice with salt and applying hot oil on the wearing parts. Failure of the brakes to release is also caused by weak or broken releasing springs, which, of course, should always be displaced by new ones.

It is scarcely necessary to point out that the brake rigging of all cars should be frequently and thoroughly inspected by men who are fully competent to adjust the rigging properly, since the safety of passengers and employees depends upon the proper action of the brakes.

Lessons in Practical Electricity

COUNTER-ELECTROMOTIVE FORCE.

When an electric motor is in operation, there is generated in its armature winding an e.m.f., exactly as in the case of a dynamo, by reason of the armature conductors "cutting" the "lines of force" of the magnetic field. This e.m.f. is opposite in direction to the impressed e.m.f. that forces current through the motor armature winding, and consequently it tends to prevent the flow of that current. It is, therefore, known as "counter e.m.f." A comparison of Figs. 1 and 2, repeated from previous Lessons, will make this clearer. Fig. 1 represents a dynamo armature and Fig. 2 a motor armature. It will be noticed that while the direction of current flow in the windings is exactly alike in both armatures, the direction of rotation is opposite in one from the direction of the other; the dynamo armature is revolving clockwise and the motor armature counter-clockwise.

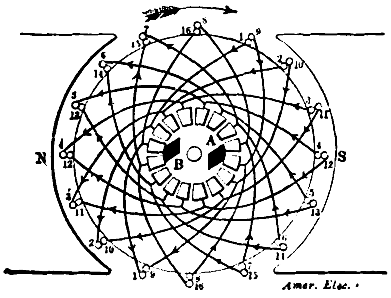

FIG. 1.

Reversing the direction of rotation of a dynamo reverses the direction of current flow through its armature, other conditions being unchanged. Therefore, if the armature in Fig. 1 were driven in the opposite direction—the same as the direction of the motor armature in Fig. 2—the current would flow in the opposite direction in the winding. This means that the e.m.f. generated would be in the opposite direction; and applying this reasoning to the motor armature, it will be evident that its generated e.m.f. is opposed to the impressed e.m.f.

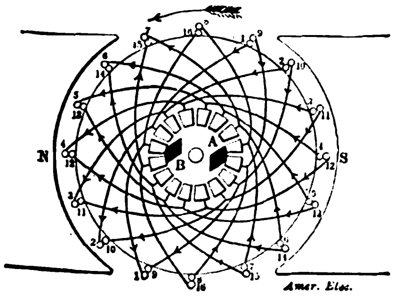

FIG. 2.

The counter-e.m.f. of a motor armature is calculated in the same manner as the e.m.f. of a dynamo armature. The formula is

$$\frac{\Phi \times w \times r.p.s.}{100,000,000} = e \ldots\ldots\ldots (1)$$

in which Φ = the total number of lines of force passing between *one* field magnet pole and the armature; *w*, the number of conductors all around the armature periphery, and *r.p.s.*, the revolutions per second. This e.m.f. must be less than the e.m.f. applied to the armature from outside—the impressed e.m.f.—in order for any current to pass. Representing the impressed e.m.f. by *E*, the total armature current by I_a, and the resistance of the armature winding and brushes by R_a, the speed of the armature must be such as to make the counter-e.m.f., *e*, equal to $E - I_a R_a$. This the motor itself accomplishes automatically.

The pull at the periphery of the armature is directly proportional to the current flowing through the armature, and this is determined by the counter-e.m.f.; the counter-e.m.f. in turn is determined by the speed. Thus, suppose a motor, supplied from a constant-potential source, to be pulling a certain load, requiring 10 amperes in the armature; now if the load be doubled, it will drag down the speed, and this will reduce the counter-e.m.f., thus permitting more current to pass through and increasing the torque. The speed will continue to drop until the armature current has increased sufficiently to pull the load.

The torque of a motor is usually expressed in "pound-feet," and is the product of the pull at the periphery × the radius of the armature in *feet*. The rate at which a motor does work, measured in watts, is the product of its counter-e.m.f. × the armature current. The rate measured in foot-pounds per second is the product of the revolutions per second × the armature circumference in feet × the pull at the circumference. Expressed as a formula, this last statement becomes

$$\frac{\pi d}{12} \times r.p.s. \times P = Ft.\ lbs.\ per\ sec. \ldots (2)$$

where *d* is the armature diameter in inches, and *P* the pull in pounds at the periphery. The rate of working in foot-pounds per second is equal to the rate in watts divided by 1.3563; and as the rate in watts is $e I_a$, and $e = \Phi\, w\, r.p.s. \div 100,000,000$, we have the relation

$$\frac{\Phi\, w\, r.p.s.\, I_a}{135,630,000} = Ft.\ lbs.\ per\ sec. \ldots (3)$$

and consequently

$$\frac{\Phi\, w\, I_a}{135,630,000} = \frac{\pi\, d P}{12}$$

which reduces to

$$\frac{\Phi\, w\, I_a}{35,500,000} = d P.$$

The pull at the periphery is therefore given by the formula

$$P = \frac{\Phi\, w\, I}{35,500,000\, d} \ldots\ldots\ldots\ldots (4)$$

The only factor in this formula that is difficult to determine is the flux, Φ. This may readily be calculated, however, by means of the two formulas

$$\Phi = \frac{100,000,000 \times e}{w\, r.p.s.}$$

and

$$e = E - I_a R_a.$$

The formula (4) for peripheral pull has been deduced here because it is much more useful practically than the formula

$$\frac{B l w i}{K} = P$$

which was given last month and is commonly given in text books.

Letters on Practical Subjects

Carrying Capacity of Interior Wiring.

To the Editor, American Electrician:—

The writer has been working recently on an interior installation where the wiring had to conform to Lloyds' rules instead of those of the National Board of Fire Underwriters, and some points have come up where the two sets of rules clash. For example, rules 21-c and 53-b, of the National code, specify that automatic cut-outs must be provided with fuses, the rated capacity of which does not exceed the allowable carrying capacity of the wire, and that fuses must be stamped with 80 per cent. of the maximum current they can carry indefinitely. Lloyds' rule No. 19 states that all fuses should be so proportioned as to melt with a current 100 per cent. in excess of the normal current; that is, they should melt with a current in the proportion of 2000 amperes per square inch of cross-section to the wire they protect.

The accompanying table has been prepared to give a comparison between the carrying capacity of different sizes of wire under both sets of rules, and also the fuse capacity according to both sets of rules.

COMPARISON OF LLOYD'S AND NATIONAL CARRYING CAPACITIES.

B. & S. Gauge	Wire Carrying Capacity		Fuse Melting Point	
	Lloyds	N.B.F.U.	Lloyds	N.B.F.U.
18	1.3	3	2.6	3.8
16	2.0	6	4.0	7.5
14	3.2	12	6.4	15.0
12	5.1	17	10.2	21.2
10	8.1	24	16.2	30.0
8	13.0	33	26.0	41.2
6	20.6	46	41.2	57.5
5	26.0	54	52.0	67.5
4	32.8	65	65.6	81.2
3	41.3	76	82.6	95.0
2	52.1	96	104.2	120.0
1	65.7	107	131.4	133.8
0	82.9	127	165.8	158.8
00	104.5	150	209.0	187.5
000	131.7	177	263,4	221.2
0000	161.2	210	322.4	262.5
Circ. Mils				
200000	157	200	314	250
300000	235	270	470	338
400000	314	330	628	413
500000	393	390	786	487
600000	471	450	942	563
700000	550	500	1100	625
800000	628	550	1256	688
900000	707	600	1414	750
1000000	785	650	1570	813

Reference to this table will show that the discrepancy between the two sets of rules is not serious for small wires, but as the sizes increase beyond No. 1 gauge the difference becomes dangerous, especially above 500,000 circular mils cross-section, as the safe carrying capacity under Lloyds' rules becomes gradually more and more in excess of that allowed by the National code. It will be noticed from the table that the safe carrying capacity, according to Lloyds' rules, is made directly proportional to the cross-section of the wire, so that the fact that masses of the same substance are cooled in proportion to their radiating surface is ignored.

There is no rule in the Lloyds' code as to the setting of circuit-breakers, so that it is probable that the practice here would follow the rule for fuses. If any of the readers of the American Electrician can offer a reasonable explanation of these discrepancies, the writer would be very glad to hear from them.

H. Joseph.

New London, Conn.

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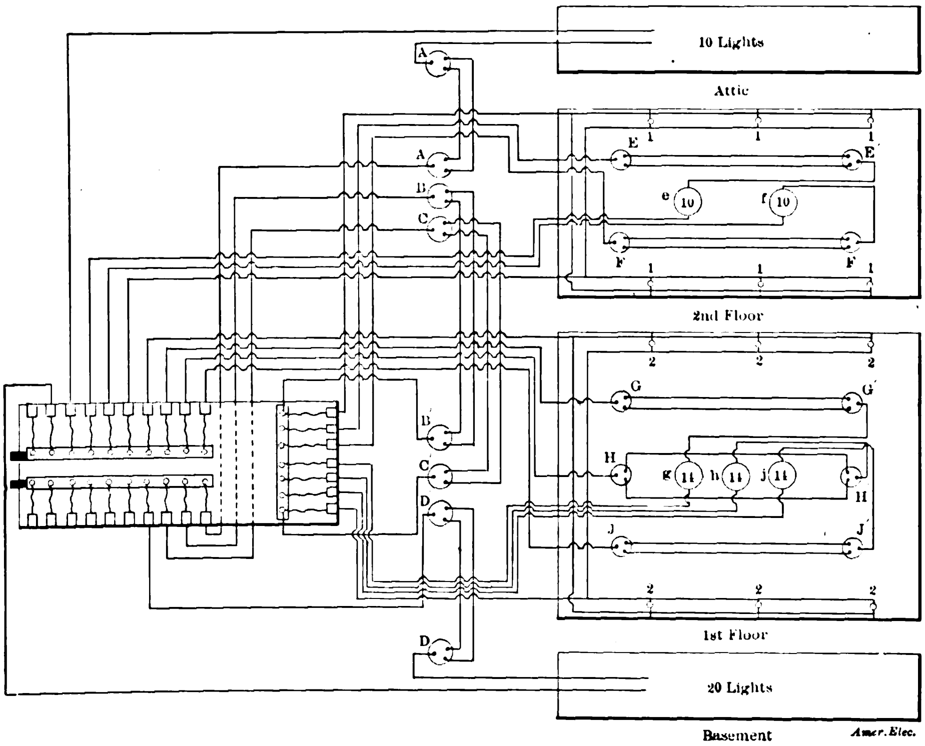
The Solutions to Mr. Cummings' Problem.

To the Editor, American Electrician:—

In the diagram, Fig. 3, contained in the September number of the American Electrician, which I submitted as a solution of Mr. Cummings' problem in wiring, it will no doubt be noticed that the bus-bar for the auxiliary bank of fuses at the right-hand end of the tablet board should be divided into two parts so as to allow switches *B'* and *C'* to work independently of each other. Such was my intention, but it was inadvertently left out.



MR. HARRIS' SOLUTION.

Frank Harris.

Sackville, N. B.

To the Editor, American Electrician:—

Referring to my solution of Mr. Cummings' problem, which you published last month, it occurred to me too late for correction that my diagram failed to comply with the Underwriters' requirements in that single-pole switches were used for all of the circuits. As the Underwriters' rules do not allow more than 660 watts to be controlled by a single-pole switch, the circuits carrying loads larger than that should have been provided with double-pole double-throw switches, and the connections altered accordingly.

H. G. Osborne.

Brooklyn, N. Y.

To the Editor, American Electrician:—

In my solution of Mr. Cummings' problem as it appeared in last month's American Electrician, a misprint occurred in the middle of the third column on page 446. The sentence "The switches may be either snap switches or double-pole single-throw knife switches" should have read, "The switches may be either snap switches or single-pole double-throw knife switches."

Referring to Mr. Cummings own solution, I wish to point out that the two-way snap switches *C* and *C'* carry 27 amperes, and there is no fuse protection whatever back of them; also the three 14-light outlets are supplied each by a single circuit. In Mr. Brown's solution he shows 20 lights on a single circuit in the basement. All of the features mentioned are contrary to the Underwriters' rules and, it appears to me, vitiate the solutions.

Geo. A. Burnham.

Winchendon, Mass.

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Determining Arc Lamp Connections.

To the Editor, American Electrician:—

In the Queries and Answers department of the September number the answer to a question by "J. A. M.," as to the method of determining when an arc lamp is connected properly in circuit, directed the inquirer to let the lamp burn for an hour or two and then inspect the carbons to determine their shape. I would suggest that instead of following this course it is better to allow the lamp to burn for a few minutes only and then cut it out of circuit and notice which carbon remains hot the longer; this one will be the positive carbon and should, of course, be the upper one of the two. If the lower carbon remains hot longer than the other one, therefore, the lamp connections should be reversed. This method gives a great saving of time over the method proposed by the answer to "J. A. M.'s" query, and is the method followed in a great majority of the stations in this country.

Arthur Joslyn.

Lynn, Mass.

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Repairing Arc Lamps.

To the Editor, American Electrician:—

A case of "intelligent" repairing which came under the writer's observation recently, may be of interest to the readers of the American Electrician. An arc lamp in a large store in this city "had something the matter with it," according to the proprietor's complaint, and was therefore sent to a contractor to be repaired and returned. Within a few days after this was done and the lamp restored to the circuit more troubles developed. The lamp passed excessive current, the carbon rod jammed in the guide plates so that the clutch could not pick it up, and, finally, the magnet coils and the series resistance coil burned out. The last troubles being so numerous and serious, the lamp was sent to the manufacturer for repair. Upon investigation it was found that the man who made the repairs the first time had not replaced the bushings which insulate the machine screws fastening the lamp top to the mechanism frame, but had filled the holes with sealing wax before replacing the screws. Of course, the sealing wax was a very good insulator so long as it was cold, but if the repair man had indulged in a little thought he should have known that after the lamp was put into operation and became hot the wax would melt and run out of the holes, allowing the mechanism frame to be grounded on the lamp top, throwing it out of plumb so as to jam the carbon rod, and eventually burning out the coils.

The moral, of course, is that any one who undertakes to repair electrical apparatus should not use slipshod methods nor substitute materials different from those originally provided by the manufacturer of the apparatus.

F. R. Shaw.

New York.

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An Electric Thermostat.

To the Editor, American Electrician:—

The accompanying sketches illustrate an electric thermostat which has given perfect satisfaction for several years, and may, therefore, be of interest to your readers. Fig. 1 represents a series of thin copper tubes, *1*, one end being spun shut, and the other end being let in and soldered to the piece, *2*, which is hollow and provides a passage to the outer glass tube at *13*. A teat on the left-hand bulb of this tube (Fig. *2*) is let in and cemented in the hole, *13*. The tube *3* is partially filled with mercury, as indicated, and a platinum wire is sealed in the bottom and connected to the middle binding post. The space in the left hand bulb (Fig. 3) and the nest of tubes, *1*, is filled with alcohol, and inner glass tubes, *11*, and rods, *9*, with platinum tips at the lower ends, are inserted in both legs of the U-tube; *10*, *10*, are guide books, and *12* is a milled-headed screw, by means of which the position of the rods can be adjusted.

The working of the thermostat is as follows: When the temperature changes, the alcohol in the left-hand tube expands or contracts, and the column of mercury rises or falls. If the temperature rises, the mercury in the right-hand leg rises, and contact is made with the platinum rod in that leg, connecting the middle and right-hand binding posts. If the temperature falls, the mercury rises in the left-hand tube, and the circuit is completed on the left-hand side.

It is impossible to get just the exact quantity of alcohol in the tubes, *1*, and, therefore, an adjusting screw, *4*, is screwed into the body of the tubes, by means of which the column of mercury can be adjusted. The inner tube, *11*, on the left-hand leg serves to keep the alcohol sealed from the air, while the other inner tube, in the right-hand leg, serves merely to keep the section of both tubes the same. This is essential when the instrument is set to regulate at different temperatures. The bulbs are provided in the tubes to prevent the mercury from overflowing at the top, when the temperature rises very high or falls very low.

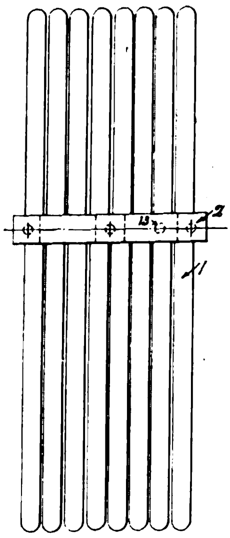

FIG. 1.

In setting up this thermostat, a position should be chosen so as to admit of a free circulation of air. Once the instrument is adjusted to work properly for the temperature indicated by the thermometer, *5*, the milled-head screw *12* is turned to whatever temperature it is desired to keep the air of the room. The electrical connections may be led to an electromagnetic damper or ventilator valve mechanism, so that any change of temperature will cause the turning on or cutting off of a supply of heat or cold.

Philadelphia, Pa. FRANK B. KLEINHAUS.

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Lignite as Fuel.—Lignite is used as fuel under 21 boilers, giving 5400 horse-power, at Bitterfeld, Germany. It is carried from the mines to the bunkers at one-third the cost of coal.

Electrical Catechism

706. How may neilling be produced on silver?

By neilling is understood the inlaying of the designs produced either by engraving or stamping with a black mixture of metallic sulphides. To imitate neil by electrodeposition the design is executed as before, and the portions which are to remain free covered with "stopping-off" varnish and the design uncovered with very dilute nitric acid. The article is then brought as the anode into a dilute solution of ammonium sulphide while a small sheet of platinum connected to the negative pole is dipped into the solution. Sulphide of silver being formed, the design becomes rapidly black-gray and after removing the "stopping-off" varnish with benzine stands out in sharp contrast from the white silver.

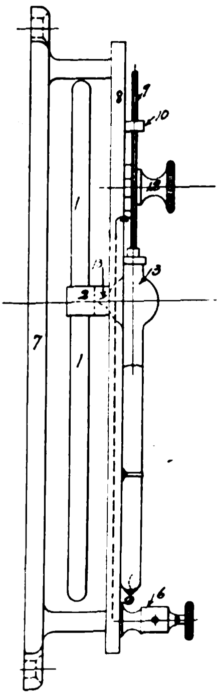

FIG. 2.

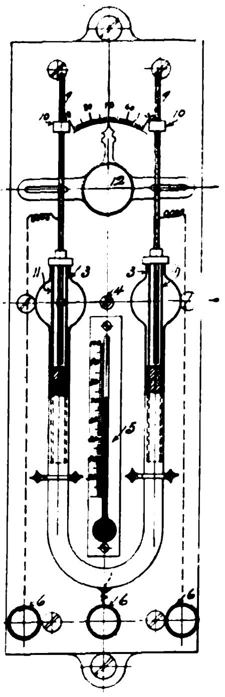

FIG. 3.

707. How may silver be oxidized?

The term "oxidized silver" is incorrect, as by it is understood not an oxidization but a combination of sulphur or chlorine. A solution of pentasulphide of potassium (liver of sulphur of the shops) is generally used for the purpose. Immerse the articles in a solution of 2.75 drachms of liver of sulphur, 5.5 drachms of ammonium carbonate in one quart of water heated to 1176 degrees Fahrenheit, and allow them to remain until they have acquired the desired dark tone. Immediately after immersion the articles become pale gray, then darker, and finally deep black-blue. For coloring in this manner the silvering should not be too thin. For articles with a very thick deposit of silver a solution of double this strength may be used. Very slightly silvered articles cannot be oxidized in this manner, as the bath would remove the silvering, or under the most favorable circumstances produce only a gray color. If the operation is not successful, and the articles come from the bath stained or otherwise defective, dip them in a warm potassium cyanide solution, which rapidly dissolves the silver sulphide which is formed.

707. How may silver be recovered from old silver baths?

Old solutions which contain silver in the form of a silver salt are easily treated. It is sufficient to add to them in excess a solution of common salt or hydrochloric acid which will precipitate all of the silver as chloride of silver, which, after washing, may be employed for the preparation of new baths. If the bath is a cyanide solution, it is evaporated to dryness, and the residue mixed with a small quantity of calcined soda and potassium cyanide, and fused in a crucible, whereby metallic silver is formed, which, if the heat has been sufficient, will be found as a button upon the bottom of the crucible. If it is not desirable to heat the silver to its melting point, the fritted mass is dissolved in hot water, and the solution containing the soda and cyanide quickly filtered off from the metallic silver. From acid mixtures used for stripping, the silver may be obtained as follows: Dilute the acid mixture with 10 to 20 times the quantity of water and precipitate the silver as chloride of silver by means of hydrochloric acid. When a drop of the acid produces no chloride of silver in the clear fluid, the addition of acid must cease. The chloride of silver may then be filtered off, washed, and either directly dissolved in potassium cyanide or the silver may be regained as metallic silver by fusing the chloride of silver with calcined soda and wood charcoal powder, previously thoroughly mixed. A still simpler method is the reduction of chloride of silver by pure zinc. For this purpose the chloride of silver is suspended in water, hydrochloric acid added, and pure zinc rods or granulated zinc placed in the fluid. The zinc dissolving, metallic silver is separated and may be filtered off, washed, and dried.

708. How may silver plating be determined?

By applying to a genuine silver plating a drop of nitric acid having a specific gravity of 1.2, in which red chromate of potash has been dissolved to saturation, a red stain of chromate of silver is formed. This method may also be used to a certain extent for recognizing other white metals which may be mistaken for silver. A drop of the mixture applied to German silver becomes brown, no red stain appearing after rinsing off the water; upon Britannia the drop produces a black stain; zinc is etched without a colored spot remaining behind; upon amalgamated metals a brownish precipitate is formed, which does not adhere and is washed away by water; upon tin the drop acquires a brownish color and by diluting with water a yellow precipate is formed; upon lead a beautiful yellow percipitate may be obtained by treating it with a drop of the solution.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Is there any means by which the voltage of a unipolar dynamo can be changed from 2 or 5 volts to 100 or 110? P. C. J.

No.

Does it make any difference whether a spark coil in a circuit such as those of electric gas lighters, gas engine igniters, etc., is connected in the positive or negative lead from the battery? C. W. R.

No.

Can an intermediate set of brushes be applied to an ordinary direct-current dynamo midway between the positive and negative brushes and be connected to the neutral wire of a three-wire circuit? W. S.

No.

If one of the circuits of a Brush multi-circuit arc machine is open and grounded, what would be the voltage at the brake? (2) What is steam? L. L. P.

The full voltage of the machine. (2) Vaporized liquid.

Can the 1-h.p. 110-volt four-pole motor with a drum armature described in "Electrical Designs," be operated as a dynamo, and, if so, what will its capacity be? L. D.

Yes; the machine will maintain about 15 incandescent lamps of 16 candle-power each.

The commutator of an old United States dynamo gives trouble from heating. The armature winding is in good condition and entirely free from short-circuits or grounds and the commutator does not appear to heat any more under full load than under no load. There is no sparking at the brushes. What is the cause of the heating? W. C. R.

The tension of the brush springs is evidently much too strong.

Would the efficiency of a Rhumkorff coil for giving a 24-in. spark be seriously affected if the construction were such that the primary coil and the core were removable? (2) What percentage of the primary energy and e.m.f. could be delivered at the secondary terminals? (3) What voltage would a spark across 24 ins. of dry air represent? R. C. J.

No. (2) It is impossible to determine this. (2) Aproximately 235,000 volts.

When can the underwriters' rule concerning the limit of 660 watts in a circuit be violated? If the rule is rigid, how are large chandeliers wired? F. J. E. S.

This rule can never be violated, except by permission given in writing by the Inspection Department of the National Bureau, and this permission is only given in the cases of large chandeliers, stage borders and illuminated signs.

Will a Nernst lamp that works on alternating current work on direct current also? (2) A Nernst lamp that had been working on alternating current was put on a direct-current circuit of the same voltage and the glowers burned out in about ten minutes; what was the cause? A. D.

Yes; but the life will be shorter. (2) The glowers had probably served almost their full life before the change, and the more rapid deterioration on the direct-current circuit hastened the end.

Does the resistance of an incandescent lamp increase or decrease with service, and how does the current consumption compare with the candle-power as the service goes on? F. K.

The resistance increases throughout the life of the lamp, so that the current consumption decreases. The candle-power also decreases, however, and more rapidly than the decrease in current consumption, so that the power consumed per candle-power of light given out increases throughout the life of the lamp.

What are the relative heating values of gasoline, kerosene and ordinary illuminating gas, as used in internal-combustion engines? J. F. S.

Ordinary commercial gasoline has a calorific value of about 11,000 heat units per pound; petroleum of a specific gravity of .87 has a value of 18,000 heat units per pound; kerosene of a specific gravity of about .8 has a value of 19,000 to 20,000 heat units per pound; the calorific value of illuminating gas varies greatly with the character of the gas, ranging from 500 to 700 heat units per cubic foot.

If two equalizing rings on the armature of a multipolar machine give a certain degree of benefit, will a larger number of rings increase the advantage in direct ratio to the number? (2) Can equalizer rings be used with a winding in which the number of coils cannot be divided without a remainder by the number of poles? (3) Does it make any difference whether the equalizer rings are connected at the front or the back end of the armature? (4) In a 12-pole machine having 696 armature coils, what would be the best number of equalizer rings to use? J. D.

No; it is rarely advantageous to use more than four equalizer rings. (2) Yes. (3) The connections should be made at the commutator end. (4) Three.

Is there more resistance in a wire wound on an iron core than when the wire is straight? (2) Is a current supposed to flow around and along a wire as though following a screw thread? (3) Does it make any difference whether the field coils of a series dynamo are connected between the positive brush and the line, or between the negative brush and the line? A. T. O.

No; but if the coil is traversed by alternating current its *impedance* will be higher than that of the uncoiled wire. (2) No; the current is supposed to flow straight along the wire, and to set up magnetic lines of force which encircle the wire at right angles to the direction of the current. (3) No.

Is it permissible under the underwriters' rules to use weather-proof wire in unfinished attics? (2) In case of a three-wire circuit with a grounded neutral, will a double-pole switch, cutting off the outside wires, at a translating device be sufficient? (3) Will a single-pole three-point switch for double-station control of circuits carrying more than 660 watts be permitted? (4) Can more than one wire be run through flexible conduit? C. J. D.

Probably not unless the attic is regularly visited by some one capable of judging the condition of the wiring. (2) Yes, so far as personal danger is concerned, but a triple-pole switch is always preferable. (3) No. (4) Yes; preferably all the wires of a given circuit.

How can the horse-power required in an engine for driving a three-phase generator be computed from the output of the generator? W. J. F.

By means of the formula,

$$\frac{1.73 \times E \times I}{746\ e} = \text{Horse-power Applied.}$$

In this formula E is the voltage of the machine, I is the current per phase on non-inductive load, and e is the commercial efficiency of the alternator. The "horse-power applied" means the power delivered to the alternator shaft; the indicated horse-power of the engine must, of course, be greater than this, the difference depending upon the mechanical efficiency of the engine.

By what simple method can an alternator be tested for regulation? R. E. L.

By providing a water rheostat which will give the alternator its full load; running the machine without load and at normal speed and voltage, then throwing on the load and noting the speed and the voltage with the full non-inductive load. Calling the no-load speed S and the speed when running under full load s; the no-load voltage, E, and the voltage under full load, e, the percentage of regulation will be given by the formula:

$$100 \times \frac{E - \dfrac{eS}{s}}{E}.$$

What is the best method of adding to the generating equipment of a three-wire system in which the old Edison method of using a dynamo on each side of the neutral is employed? (2) What is the usual method of applying alternating current to shop lighting; from the generator direct or through transformers? (3) How should the magnets of an arc lamp be rewound to change it from a 50-volt 4-ampere lamp to a 50-volt 8-ampere lamp? A. F.

Add a 220-volt machine, connecting it to the outer wires of the system, of course. (2) For small shops a low-voltage alternator supplying the circuits direct is the best. For large establishments comprising several buildings covering a large area of ground, transformers would be preferable. (3) Rewind the series magnets with wire three gauge numbers larger than the present wire, putting on exactly one-half the number of turns per coil that the present coils contain. The shunt magnets do not require any change.

At what point in a circuit does a positive current become negative? (2) Can arc lamps adapted to work on pulsating direct current be operated on alternating-current circuits? (3) What prevents a shunt-wound motor from running away when the load is suddenly thrown off? (4) What is the best method of varying the speed of a constant-potential motor? S. T. W.

There is no such thing as a positive or negative current. The terms "positive" and "negative" are merely relative, and used to indicate the direction of the so-called current "flow," the current being said to flow from a positive point to a negative one. The current itself has no polarity. (2) No. (3) Refer to the Lessons department in this issue. (4) Within a small range, altering the field strength by means of a resistance in series with the winding. For great ranges of speed variation, specially-wound machines are used; sometimes two distinct armature windings and commutators are employed, the commutators being connected in series for very low speeds and in parallel for the higher ones, and intermediate gradations being effected by varying the field strength.

DISTRIBUTION OF LIGHT FROM THE NERNST LAMP.

BY ALEXANDER JAY WURTS.

The engineers who developed the Nernst lamp kept in mind from the outset the importance of a correct distribution of light and before determining the general form of the new lamp, studied carefully the desirable and objectionable features of other illuminants. It was found that the horizontal rays from the arc lamp, for instance, were generally unsuitable and, after careful consideration, it was decided to obtain a more downward distribution of light from the Nernst lamp. In this connection it is interesting to note what distribution of light is found in nature. The sun at rising and setting projects its rays almost horizontally, but the light at such times is much softened and the intensity greatly reduced. During the working hours of the day, however, the sun reaches a position in which the light can be greatly intensified without injury or discomfort to the eye, which is well protected from these vertical rays.

Light projected in a horizontal direction is distressing to the eye, and distribution of intense light in this direction is rarely found in nature. At the same time it is uncomfortably evident that horizontal distribution is found in the methods of street lighting now in vogue. This refers more particularly to the arc lamp, which throws an abundance of light horizontally along the street, much after the manner of a searchlight or locomotive headlight, with the result that rays of great intensity are projected into the eye.

In the Nernst lamp this defect has been mitigated by imitating more closely the natural distribution and in a number of places where the Nernst lamp has been introduced for street illumination, the results have been found wonderfully pleasing. The lamps have been placed at about the same elevation as the ordinary arc lights, and at varying intervals according to the size of the unit selected. The result is that instead of the unsteady horizontal beams and the dense shadows underneath the arc lamp, there is a soft white light evenly distributed over the street, to the great relief of the eye.

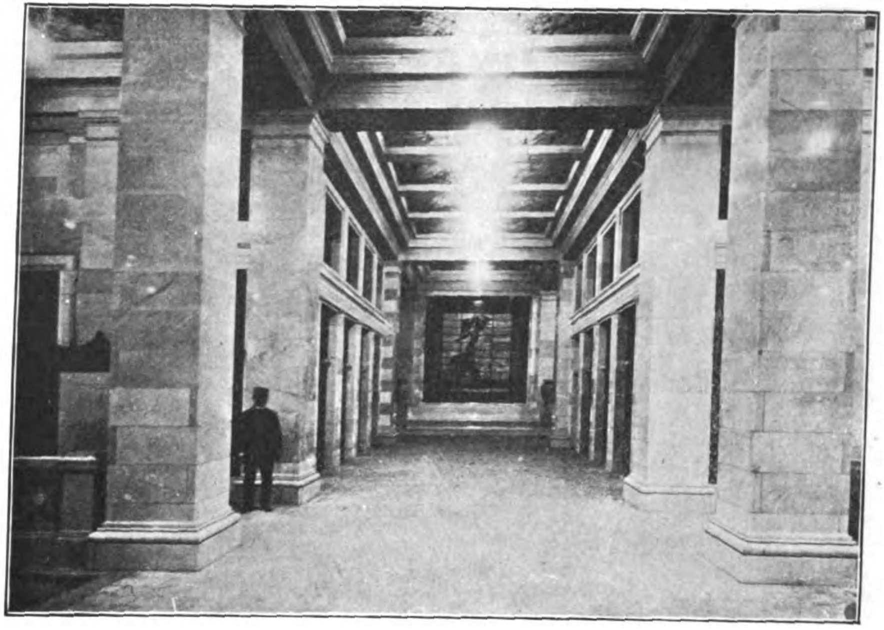

FIG. 2.—NERNST LAMP ILLUMINATION IN CORRIDOR.

In addition to this feature of throwing the light downward, the beautiful quality of the light emitted by the Nernst lamp has already made this form of illuminant very popular in dry goods stores and other places of a similar character where a correct determination of color is important. Moreover, it is interesting to note the pleasing effects which are now being produced with the Nernst lamp by using in large interiors only one quality of light, in distinction to the always unpleasant and inartistic combination of the bluish-white arc light and the yellow incandescent lamp. In this respect, the Nernst lamp possesses a uniform quality of light in all its sizes and is the only electric light capable of being made in a practical and efficient form for both high and low candle powers.

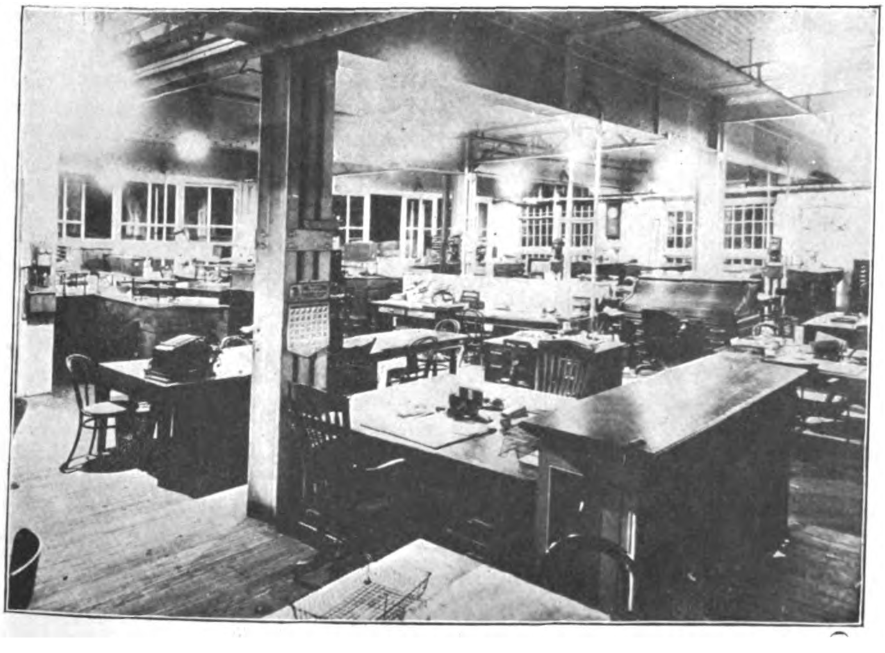

FIG. 1.—OFFICE ILLUMINATED BY NERNST LAMPS.

The rapidly increasing use of the Nernst lamp has brought out another feature with reference to artificial illumination, namely, a distinction between illumination and so-called artistic lighting. The latter is a field occupied almost exclusively by the incandescent lamp. Under artistic lighting may be classed illumination such as is now used on the outlines of large buildings, including, for instance, the beautiful effects produced at expositions, as on the Electric Tower at the Pan-American Exposition; also interior decorative work where color and the artistic location of the units of light are of primary importance. Under this head may also be included electric signs. However, where general illumination is desired, it is obviously inefficient as well as objectionable from an optical point of view, as already shown, to place the units of light within the line of vision and then to throw the light upward, as is so often done with incandescent lamps.

An illuminant pure and simple should be placed well above the line of vision; in short, the location of the units of light should be such as to distribute the light in a manner more closely conforming to nature. In other words, the lamps should be properly located in the ceiling and the light thrown downward; but here also an error is easily made. Frequently a ceiling is studded with small units of light, the idea being that an absolutely uniform distribution of light makes such an arrangement imperative. This may be overdone. The heavens are not studded with small, brilliant lights; on the contrary, the light comes from a single source placed at practically an infinite distance. It is not possible to fully repeat these conditions, nor is an approximation to them more nearly obtained by studding the ceiling with unnecessarily small units. The objection to an absolutely uniform distribution of light in a room is that it destroys all shadow and gives one a weird impression. Not only is one's perspective thus distorted, but all the delicate lights and shades which otherwise make things appear beautiful are lost. On the other hand it is not necessary to go to the other extreme and place a single powerful light in the ceiling of a room, thereby casting unnaturally dense shadows. If it were possible to place such an illuminant at a proper distance above the floor the result would approximate to nature; but with the ordinary ceiling it is necessary to choose a happy medium, which will not be in the single large unit nor yet in the multiplicity of very small units, but in a sufficient number of properly proportioned lights so located as to cast pleasing lights and shadows.

Following along these lines, it may be still further shown that drop lights and side lights are not only unnatural but actually injurious to the eye; this includes also the desk light now commonly seen in all offices. The latter is usually provided with a green shade and casts a bright spot of light upon the letter paper, but if the eye is raised the muscles immediately relax to accommodate themselves to the darkness of the room and when they are again turned to the desk they contract. Such repeated involuntary action of the muscles of the eye must sooner or later produce harmful results.

The first requisite of artificial lighting is a fair general illumination from above; then, if a reading or writing light is desired, it should be located well above the eye and back of the reader so that the light will be cast over the left shoulder. As a writing light, the lamp may be placed above the line of vision, preferably six feet from the floor and about a foot to the left of the writer's head, so that no shadow will be cast by the writing hand. The light should be thrown downward, giving a good general illumination over the entire desk or writing table.

To obtain these results has been the object of the makers of the Nernst lamp, and users of light are already learning to appreciate the benefits to be derived from such a distribution. The illustrations which accompany the text show the soft and pleasing effects resulting from the use of this type of lamp in commercial service.

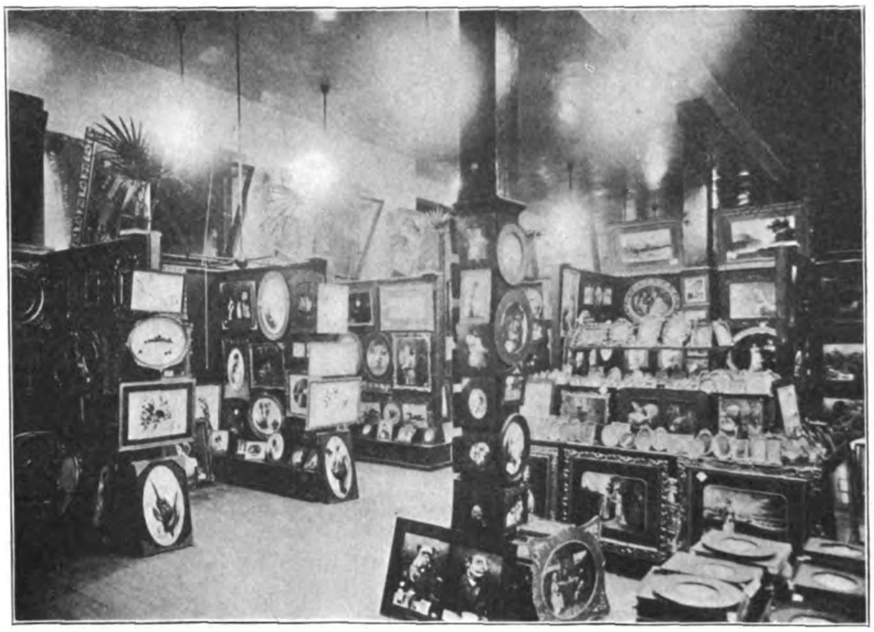

FIG. 3.—NERNST LAMPS IN A DEPARTMENT STORE.

VARIABLE SPEED ELECTRIC MOTOR.

The application of electricity to the direct driving of individual machine tools, as well as many other classes of machinery requiring independent direct drive in shops and factories, has long been regarded as a promising field for development. In the exploitation of this field, however, progress has not been as rapid as might be expected. This has been due to the lack of a motor, which, besides being economical and reliable, could adapt itself to a wide range of conditions of speed and load. The well-known multi-voltage system solves this problem indirectly, the different voltages enabling the motor to run at correspondingly different speeds. Another solution is found in the motors whose field poles are provided with cores arranged to be moved to and fro from the armature, thereby varying the strength of the field, and hence the normal speed of the motor correspondingly. In the Storey motor, built by the Storey Motor and Electric Company, of Harrison, N. J., the aim has been to accomplish the same result, but in a much simpler manner. The motor possesses a very wide speed range, and operates throughout this range equally economically and with equal ability to adapt itself to changes of load.

Machines are in every day use with a varying speed of 200 per cent., obtained by varying the field current of a simple shunt-wound motor by means of an ordinary field rheostat, for, as is well known, with a shunt motor the speed increases when the

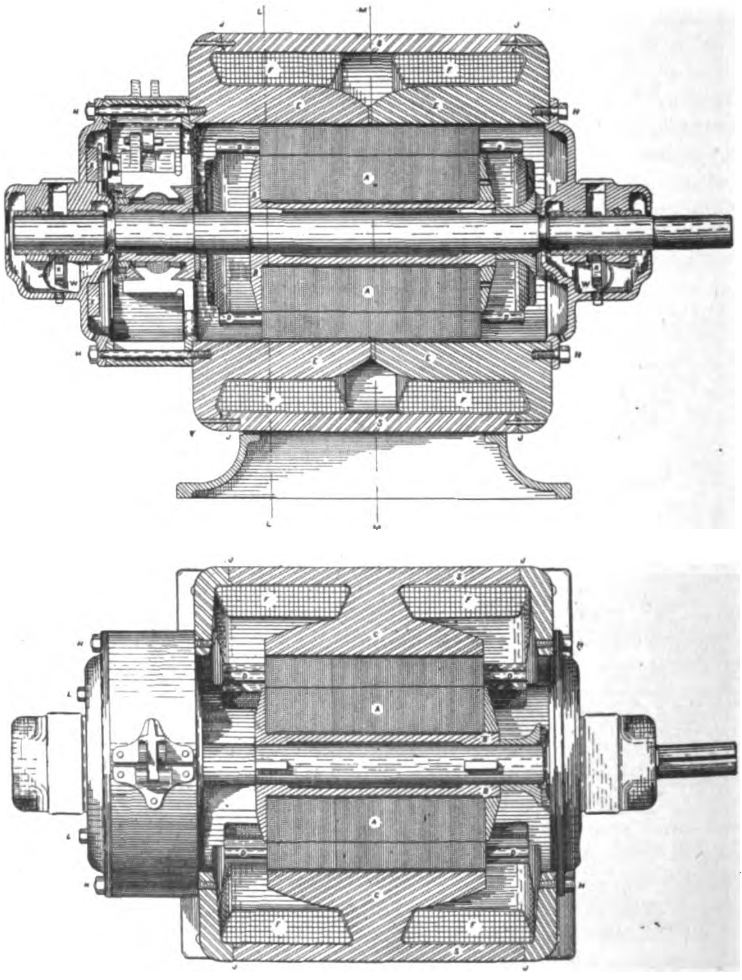

FIG. 1.—SECTIONAL VIEWS OF STOREY MOTOR.

field is weakened, and decreases when the field is strengthened, other conditions remaining the same. With the ordinary shunt motor, however, any considerable change in field causes bad sparking at the commutator, but the Storey motor is said to give no such trouble. The essential parts of the motor are shown by Fig. 1, from which its construction will be understood. The center pole, *C,* and external shell, *S,* are cast in one piece; the two end poles, *E,* being connected to the shell by an invisible joint, *J,* thus enclosing and completely protecting the field coils, *F.* There are but two field coils, which are circular in shape, and surround the armature concentrically. The coils are wound on spools, then wrapped with three layers of muslin soaked in linseed oil. After being thoroughly dried, they are wrapped with three more layers, similarly treated, and then baked.

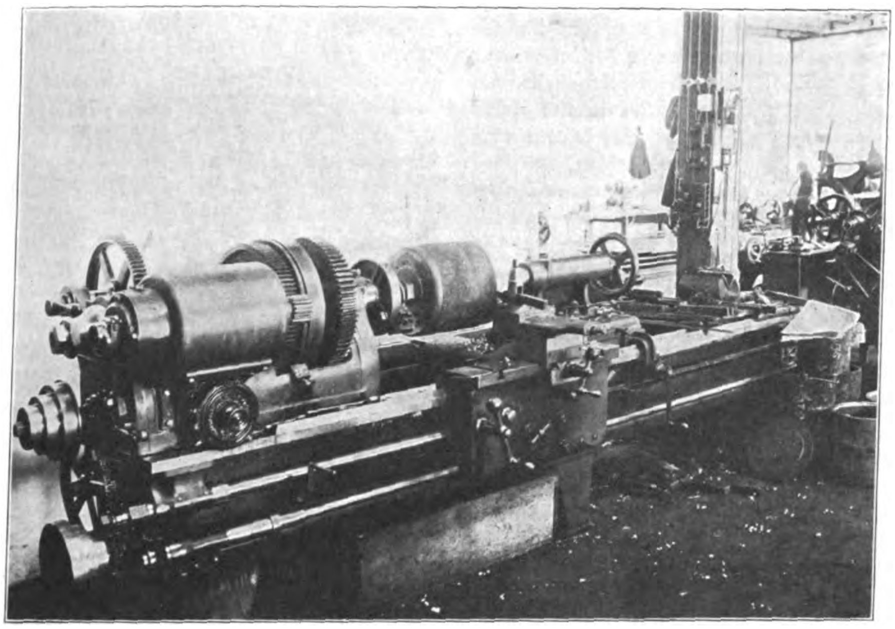

FIG. 2.—MOTOR-DRIVEN LATHE.

The magnetic circuit is from *E* through the cylinders *S* to *C,* and through the armature back again to *E.* This makes a short and effective magnetic circuit. The armature is mica-insulated with a view to having the structure resist high voltages. The coils are form-wound and put in the slots of the core in mica troughs. The armature is built, in the usual way, of discs clamped on the shaft with paper insulation with the exception that the discs are assembled on a sleeve which is keyed to the shaft, thereby making the latter removable without taking down the laminated structure. The commutator, which is mounted on a separate sleeve and keyed to the shaft also, is liberal in dimensions and well insulated with mica. The bearings of the motor are castings bolted to the pole-pieces and are self-oiling. The commutator bearing is extended beyond the frame to accommodate the commutator and brushes, and the space between the supports is surrounded by a circular steel band suitably clamped, which renders the commutator and bearing accessible. The bearing can be rotated with reference to the frame by altering the bolts, thereby enabling the motor to be run either hanging from the ceiling or side wall, or from the floor, the moving of the bearings being simply to keep the oil wells in proper position. Most of the machines and tools in the shop of the Storey Motor and Electric Company are all motor-driven, in the manner described, and the fact that the motors are cylindrical and entirely enclosed, thus protecting them from dust, oil and mechanical injury, makes them particularly suited for work under such conditions.

Fig. 3 shows one of the motors attached to a 13-inch slotter, and Fig. 2 shows a motor applied to a 29-inch lathe. This lathe is equipped with a 3-h.p. motor, which is 12½ inches in diameter, and gives a speed variation ranging from 500 r. p. m. at slow speed to 1,500 r. p. m. at high speed. This variation of speed with the Storey system of direct drive gives a range of speed at the spindle of the lathe from 3½ revolutions to 300 revolutions. There is a small field controller on the front of the lathe whereby the operator can cut out and in resistance in the field to obtain the required speed. The lathe is provided with a suitable mechanism, whereby it can be stopped and started from the tool carriage. The motor is reversed through a reversing starting rheostat having a double-pole, quick-snap break switch, operated from the front of the lathe or the carriage, and a safety stop is provided which cuts off the current before the carriage travels far enough to do damage.

In the case of the motor-driven slotter, the motor, which is a 3½-h.p., 110-volt shunt machine, has its excitation reduced from 1.55 amperes to .20 ampere, resulting in a speed increase of 600 r. p. m. to 2,400 r. p. m. Notwithstanding that the speed of the motor may be varied repeatedly between these limits, there is no perceptible sparking at the commutator. There is, moreover, a constant increase in load from the lowest to the highest speed, owing to the fact that the quick return of a slotter requires more power than the cut, and since this increases as the speed increases, the motor is operated at the highest horse-power output at its highest speed, which is rather unusual for a motor of this size and capacity.

The motor is now built in sizes from ½-h.p. to 50-h.p., and is largely used for grinding, buffing and polishing, for which purposes the smaller sizes are especially applicable, the design of the motor making it particularly valuable for buffing work. As is common with all properly-designed, shunt-wound motors, the speed is constant under varying loads or overloads, and the high speeds necessary for buffing work may be easily acqured for this work without any undue heating. The manufacturers claim that the heat rise is only 72 degrees when the buffs are running at a speed of 3,300 to 3,500 r. p. m., after being in constant use from 10 to 20 hours a day.

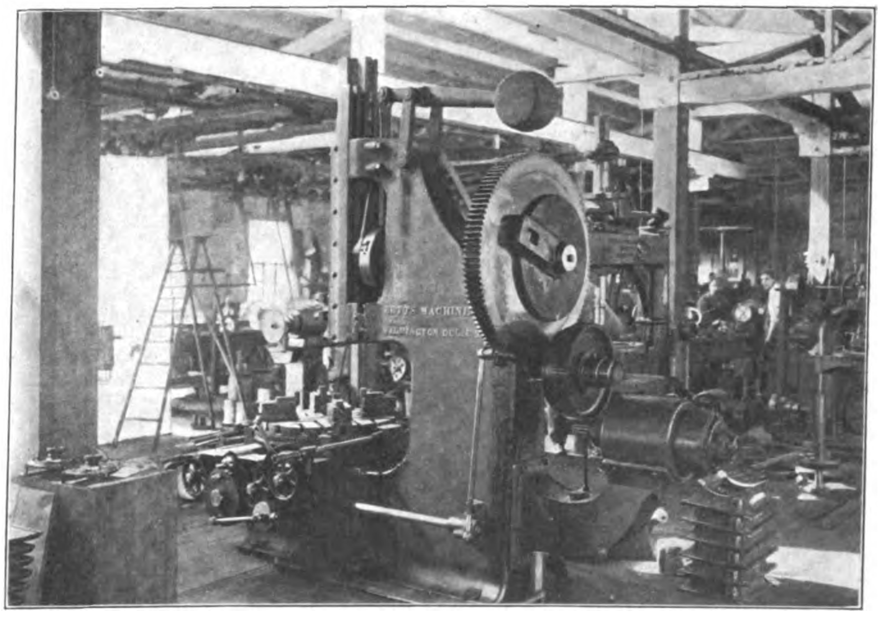

FIG. 3.—STOREY MOTOR DRIVING SLOTTER.

The value of such a simple arrangement

of a motor for driving machines and machine tools is readily appreciated. The motor, its starting box and the speed-changing rheostat are all mounted on the machine, and the speed can be set at any point or changed instantaneously to suit the work without pulleys, belts, speed-changing gears or similar devices.

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BOILER FEED WATER AND THE BACHMAN SYSTEM OF PURIFICATION.

On account of its great solvent qualities nearly all water contains more or less scale-forming matter which it takes up from the earth through which it passes. This quality of dissolving and holding in solution various solids is greatly increased by the carbonic acid gas which is contained in practically all water. These impurities depend on the character of the rocks through which the water flows and vary greatly in different locations. Moreover, the amount of scale-forming matter in any water from a stream varies also from season to season and from day to day. In a wet season or after a rain, river water will be found to be comparatively pure; the scale-forming matter having been diluted with the pure rain water. In a dry season the water will become more highly charged with scale-forming matter as its volume decreases.

Waters coming from coal mines or sulphur deposits will be found to contain amounts of sulphuric acid, sufficient to quickly corrode a boiler. Water highly charged with carbonic acid gas, as some natural waters are, will also corrode boilers. Waters containing calcium and magnesium chlorides also cause corrosion in boilers by the hydrochloric acid which is set free by the heat. Another common trouble with waters of the western United States is the alkaline compounds which are frequently found in them. These cause foaming in the boilers, especially when mud or vegetable matter is found in the water at the same time.

In a general way impurities in boiler feed water may be divided into three classes, as follows: (1) Corrosive impurities consisting of sulphuric acid, (H_2SO_4), carbonic acid (CO_2), sulphate of iron ($FeSO_4$), calcium chloride ($CaCl_2$) and magnesium chloride ($MgCl_2$). (2) Scale-forming impurities, consisting of calcium carbonate ($CaCO_3$), magnesium carbonate ($MgCO_3$), calcium sulphate ($CaSO_4$), magnesium sulphate ($MgSO_4$), iron carbonate ($FeCO_3$) and aluminum carbonate ($AlCO_3$). (3) Alkaline impurities, consisting of sodium and potassium carbonates (Na_2CO_3 and K_2CO_3), sodium and potassium sulphates, (Na_2SO_4 and K_2SO_4) and sodium and potassium chlorides ($NaCl$ and KCl).

The corrosive impurities are comparatively rare, but extremely destructive when present. They quickly eat through the thickest boiler shell and are particularly destructive to crown sheets and tubes at the points where they enter headers. Their action is so rapid and so insidious that they should never be used unless first neutralized. The danger of an explosion and loss of life is too great. Instances have been known where new boilers have been practically ruined in nine months by the use of river water containing mine water.

Distilled or absolutely pure water should also be classed as corrosive in the highest degree, as the pure water is such a solvent that it will dissolve the boiler shells. A small quantity of impurities in the water will entirely prevent this, and is therefore desirable.

Impurities of the second class are by far the most common and hardly any water is free from them. These are precipitated in the boiler by the heat and deposit themselves on the shells and tubes. They may be divided into two classes: carbonates and sulphates. The carbonates are held in solution by carbonic acid gas, and are slowly deposited as the temperature rises and the carbonic acid gas is driven off. At 200 degrees about 25 per cent is deposited, but the precipitation is not complete until the temperature reaches 290 degrees. The carbonates do not form a hard scale and are easily removed.

The sulphates are more difficult to remove, and precipitation does not begin to an appreciable extent until the water is boiling; it is not complete until the temperature of the water reaches 290 degrees. The sulphates form an extremely hard non-conducting scale, and act as a cement to bind the carbonate scale and mud into a much heavier and harder scale than would otherwise form. Mud of itself would not form scale, but in the presence of the sulphate impurities it increases the scale as described.

The average heat conductivity of scale as shown by experiments is about 3 per cent. of the conductivity of iron. Therefore it requires more coal, obviously, to make steam in a boiler scaled than in a clean one. The accompanying table shows the increase of fuel required to overcome different thicknesses of scale, and the increase in cost of evaporating each 1000 gallons of water under these conditions and at different prices of fuel.

COST OF EVAPORATING 1000 GALLONS OF WATER, ASSUMING 3 POUNDS OF COAL TO 30 POUNDS WATER.

Thickness of Scale	Increase of Fuel required	Price of Coal per Ton				
		$1.50	$2.00	$2.50	$3.00	$3.50
0	0	$0.558	$0.744	$0.930	$1.116	$1.302
1/16"	10%	.614	.818	1.023	1.228	1.432
1/8"	15%	.642	.855	1.069	1.284	1.407
1/4"	20%	.670	.892	1.116	1.340	1.562
3/8"	25%	.698	.930	1.162	1.396	1.627
1/2"	30%	.726	.968	1.209	1.452	1.693
5/8"	35%	.754	1.006	1.255	1.508	1.758
3/4"	40%	.782	1.042	1.302	1.564	1.823

Moreover, the coating on the inside of the boilers and flues keeps the cooling water away from contact with the iron of the shell and tubes. The latter are therefore subjected to a much more intense heat than they would be were there no scale, and consequently deteriorate much more rapidly. In boiler shells the scale collects over the fire and produces pockets and blisters, necessitating expensive repairs and vexatious delays. The presence of boiler scale is one of the most fruitful causes of boiler explosions known and is the evil for which boiler inspectors look first on making an examination.

The third class of impurities mentioned cannot be gotten rid of in any commercially practical method. The tendency of these impurities is to cause foaming in the boilers, especially if any mud or vegetable is in suspension in the water. In water entirely free from the latter, the alkalies can be present in great quantities without causing trouble in this manner. Thorough filtration will prevent foaming, and the ordinary blowing off of a boiler daily will prevent concentration of the alkalies to the foaming point. When such water foams the alkalies are carried out with the steam, and have a decomposing effect on the cylinder lubricant and piston packings.

In most waters, the presence of small amounts of alkaline impurities is never noticed in the boiler, even after it has been treated with soda ash to eliminate the sulphates, chlorides and nitrates of calcium and magnesium.

Many methods and types of apparatus have been devised for the purification of boiler feed-water, each having its own particular advantages and claims. One of the most recent and elaborate arrangements is the Bachman system, which is manufactured by D. W. & R. P. Patterson, of Philadelphia, Pa. Fig. 1 herewith illustrates diagrammatically the apparatus employed. The solution tank, *A*, is filled with a solution of burnt lime and purified water so as to make a milk of lime. Purified water is used because it will not cause a further precipitation in the solution tank and waste of lime when the latter is added. Ordinary fresh burnt lime is used, and this should be from as pure a stone as possible. Lime containing much magnesia should be avoided.

In order to keep this milk of lime agitated and to keep it from settling, a small quantity of water is by-passed from the discharge pipe of the lime pumps through a small orifice into the bottom of the tank, which keeps the whole contents of this tank in motion. This method is said to be preferable to the use of an air current, as the lime takes up the carbonic acid rapidly from the air mixed with it, becomes inert, and is precipitated as a waste product in the bottom of the tank.

The solution pump is a small single-action boiler feed pump, especially designed for pumping chemicals. All the working parts exposed to the action of the solutions are of a metal not affected by the same, and the piston packing is protected.

The hot feed-water, which should be at a temperature of 175 degrees or over (but is frequently less), enters the first chamber, *C*, as indicated by the arrow, and the pressure is indicated on the gauge *D*. Just as it enters, the solution of lime is pumped into it, and by an internal arrangement of the piping, not shown, is thoroughly mixed all through it. The first effect of the lime is to neutralize any free acid in the water.

If the water is taken from coal mines and contains sulphuric acid the following is the reaction:

Acid in Water — Lime Solution

$$H_2SO_4 + CaH_2O_2 = CaSO_4 + 2H_2O$$

The acid is converted into sulphate of calcium, which is disposed of later. All corrosive action will have been stopped.

The treatment of mine waters is, however, exceptional, and the chief use of the lime is to combine with the carbonic acid which all water contains to some extent and which is the great solvent, holding in solution the lime, magnesium, and iron in the form of bicarbonates.

If free carbonic acid is present in large quantities, and some waters are highly charged with it, it has a very corrosive effect on the boilers, causing the water to dissolve the shell readily. In such a case the lime added will combine with the carbonic acid, as follows:

Acid in Water — Lime Solution

$$CO_2 + CaH_2O_2 = CaCO_3 + H_2O$$

giving carbonate of lime, which is precipitated, and water.

Having thus disposed of the free acids, for which the lime solution has the greatest chemical affinity, the lime now causes the precipitation as carbonates of the lime and magnesia compounds held in solution as bicarbonates in the water.

In the case of the lime we have

Bicarbonate of Calcium — Lime Solution

$$CaO,\ 2(CO_2) + CaH_2O_2 = 2CaCO_3 + H_2O$$

which gives calcium carbonate as a grayish-white precipitate and water. The reaction with magnesia bicarbonate is similar:

Bicarbonate of Magnesium — Lime Solution

$$MgO, 2(CO_2) + CaH_2O_2 = MgCO_3 + CaCO_3 + H_2O$$

giving one atom of magnesium carbonate and one of calcium carbonate as a precipitate. Magnesium is much harder to get rid of than lime, as the magnesium also comes down as hydrate or magnesium alba. For this reason the manufacturers advise using a lime with as little magnesium as possible. Iron is also held in solution by the excess of carbonic acid, and it is precipitated by lime in the same manner as the bicarbonate of lime and magnesium.

In the case of iron the reaction is:

Bicarbonate of Iron — Lime Solution

$$FeO, 2(CO_2) + CaH_2O_2 = FeCO_3 + CaCO_3 + H_2O$$

Therefore, in this chamber all corroding acids are first neutralized.

Then the bicarbonates of lime, magnesium and iron are precipitated by taking up the excess of carbonic acid by which they are held in solution.

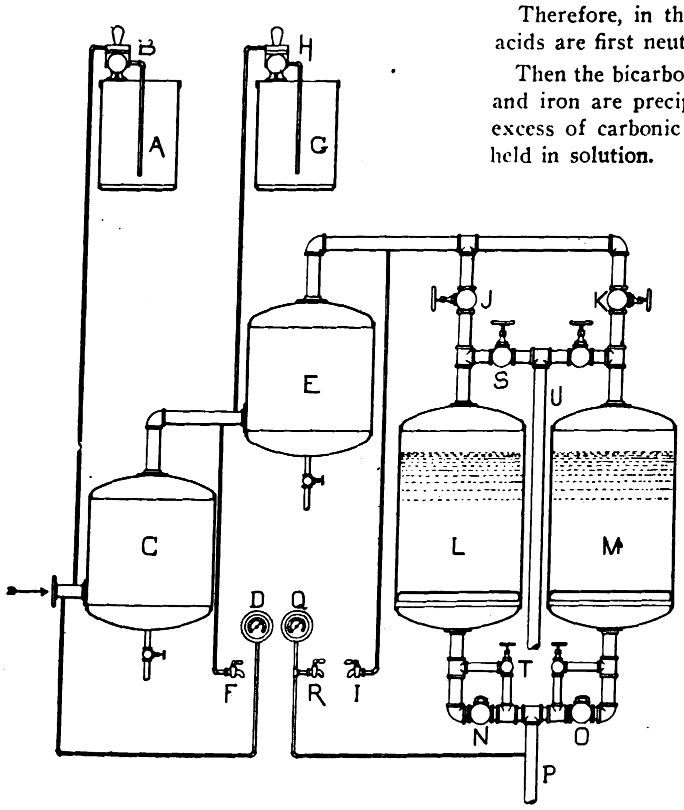

FIG. I.—DIAGRAM OF DONNECTIONS.

These precipitates settle in the bottom of this chamber, *C*, and can be blown out from the bottom from time to time. They carry down with them the greater portion of the mud.

A further effect of the lime is to convert any oil in the water into stearate of lime.

The admission of the water is so arranged that the currents will not disturb the settling of the precipitates.

The water with some precipitates, which owing to their fineness will not settle, pass out of this chamber, *C*, to the next chamber, *E*.

From the connecting pipe, just as it leaves *C*, a pipe extends to a lime test cock, *F*. At this point it must be determined whether enough lime has been added to cause the above reactions or not. This is done by drawing a small portion of water in a white porcelain cup and adding two drops of a phenolphtalein solution to each tablespoonful of water.

This is a very delicate test for alkalies, and will show a faint pink if sufficient lime has been added. If it remains white it indicates that not enough has been added, for no excess of alkali can show until all the free acids and all the carbonic acid in the water has been neutralized. If the color shows dark pink it indicates that too much lime has been added and the solution pump should be slowed up.

The solution tank, *G*, is filled with a solution of soda ash, just as described for lime in *A*, and is kept in agitation in the same manner. A solution pump pumps a solution of soda ash or carbonate of soda into the water after it has been treated with lime and just as it enters the chamber, *E*. It is thoroughly mixed with the water as it enters this chamber, and at once begins to precipitate the sulphates, chlorides, and nitrates of calcium and magnesium as carbonates.

Taking first its effect on the sulphates of calcium and magnesium, which form the hardest scale and act as a cement to bind the other impurities into a heavy scale, the reaction for sulphate of calcium is as follows:

Calcium Sulphate — Soda Ash

$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

and with magnesia sulphate

Magnesia Sulphate — Soda Ash

$$MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4$$

This gives calcium and magnesium carbonate as a gray precipitate and sulphate of soda. The sulphate of soda, like all alkali compounds, is very soluble and enters the boiler with the water.

Water sometimes contains chlorides of calcium or magnesium, and these compounds decompose at high temperatures, giving off hydrochloric acid which is very corrosive. By the addition of soda ash solution in this chamber these are disposed of as follows:

With lime,

Chloride of Calcium — Soda Ash

$$CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$$

and with magnesium chloride,

Chloride of Magnesium — Soda Ash

$$MgCl_2 + Na_2CO_3 = MgCO_3 + 2NaCl$$

Both these reactions give lime and magnesium carbonate as a precipitate and salt which enters the boilers. The quantity is so small that it cannot be noticed.

Should there be any nitrate of calcium in the water, the soda ash disposes of it by the reaction

Nitrate of Calcium — Soda Ash

$$CaN_2O_6 + Na_2CO_3 = CaCO_3 + 2NaNO_3$$

from which are obtained carbonate of lime, as a precipitate, and nitrate of soda, which enters the boilers. The bulk of the precipitates settle to the bottom of the chamber *E*, from which they can be blown out from time to time.

The alkaline impurities formed in waters consist of carbonates, sulphates and nitrates of sodium and potassium. These compounds do not form scale nor corrode the boilers at all, and are only objectional when present in quantities, when they have a tendency to cause foaming. If, however, there is no suspended vegetable matter or mud in the water, they may be present in much larger quantities and cause no foaming. The presence of vegetable matter or mud seems to greatly increase the liability to foam. There is no commercially practical method known by which the alkaline compounds may be removed from boiler feed water.

As the water leaves the chamber, *E*, a connection to a test cock, *I*, enables one to determine whether sufficient soda ash has been added or not. If there has not been enough added, on testing the water with a drop of phenolphtalein to the tablespoonful of water, one would get the same faint color as from the lime test at *F*. But where a sufficient quantity of soda has been added to combine with and precipitate the sulphates, chlorides and nitrates of calcium and magnesium, a slightly darker color is obtained at *I*, which shows that slight excess of soda has been added. The tests, which show a faint pink at *F* with two drops of phenolphtalein solution to a tablespoonful of water, and a darker test at *I* with one drop to the tablespoonful, constitute a rough but quick and practical method of determining whether the proper amount of lime and soda has been added. If the colors above specified are obtained, it is impossible for the water to contain sufficient scale-forming matter to form a scale.

The water with some suspended matter and the lighter portions of the precipitates passes through the valves *J* and *K* to the filters *L* and *M*. These are filled to a depth of 4 ins. to 6 ins. with fine crushed flint, resting on screen plates with milled slots, supported on the inside head. The remaining impurities are caught on top of the filters and the purified water passes through the check valves *N* and *O* to the pipe *P* and to the boiler.

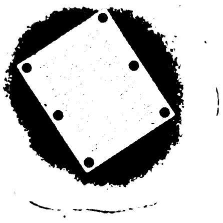

FIG. 2.—SCREEN.

From *P* a smaller pipe leads to a gauge *Q* and test cock *R*, provided for testing the purified water to see what results are being obtained. A small glass of water is drawn and six or seven drops of a saturated solution of caustic soda and soda ash are added. If there is more than a grain of scale-forming matter left in the water a precipitate will form, and if less it will remain clear. The two gauges *D* and *Q* show the pressure before entering and after leaving the apparatus. The difference, therefore, shows the pressure required to force the water through the apparatus. Now as the filtrates accumulate on the top of the flint in the filters, this difference in pressure will increase and indicates to the attendant when to wash out the filters.

One filter is washed at a time, and if it is desired to wash *L* the valve *J* at the top is closed and the valve *S*, which connects with the drain *U*, is opened. The check valve *N* prevents the water coming back from the pipe *P*. The by-pass valve *T* is then opened to allow purified water to pass up through the screen plates. This stirs up the flint and carries the accumulated filth and precipitates out through the valve *S* and drain pipe *U* to a sewer. The advantage of the flint is that it does not pack and never deteriorates; after washing it is as good as new and will last for years. The washing operation takes about five minutes.

HIGH TORQUE INDUCTION METER.

Theory requires that the torque, speed and load in all types of motor meters, should all increase in the same proportion. This is not possible, however, for the reason that torque has two factors, namely, the generation of foucault currents in the damper, which varies according to the law of the perfect meter, and the overcoming of friction, which does not vary according to such law. It is, therefore, evident that the higher the torque with a given friction, the smaller will be the deviation from the law. This principle is employed in the Thomson high-torque induction meter, made by the General Electric Company, which is shown in the accompanying illustrations. In this case the torque is made a maximum, while at the same time the utmost care has been taken to reduce the friction to a minimum. The static portion of the meter elements occupies the back of the case, and is magnetically separated from the damping magnets and shaft mechanism by a magnetic shield, shown in Fig. 1. This magnetic shield serves jointly with the iron case and cover to completely protect the damping magnets from any stray fields incident to heavy load or short-circuits which might otherwise tend to weaken the damping magnets and impair the accuracy. The case of the meter is removed directly towards the front, as shown in the illustration. It is made of cast-iron, finished in black enamel, and rests against the back frame upon felt packing, to which it is securely bound by two wing nuts, both of which may be sealed. The register is of the new "no constant" type, having five indicator hands, as on all Thomson recording wattmeters. The readings are uniform with the readings of the Thomson recording wattmeters, and may be recorded and tabulated on the same system. The binding-posts are located at the bottom of the meter, and are so arranged as to render installation easy and rapid. As friction is a variable, it is important to provide means for easily and immediately compensating for friction. The high-torque meter has been provided with a device for this purpose, which is generally known as the light-load adjustment. This device consists of a small and entirely independent torque producing structure which will be noted between the magnets in Fig. 1 and in Fig. 2. This device is provided with a movable sector, which by adjustment gives complete control of friction, compensation, and light-load accuracy, without disturbing the other essential characteristics of the meter, such as accuracy on inductive load, changes of frequency, wave form, potential and the like. The light-load adjustment device permits of a 10 per cent. speed variation plus or minus at light load without affecting general calibration. The meter, in common with all other meters of its class, must be proportioned and calibrated for the frequency upon which it is to be used. In view of the fact that 125-cycle systems are now quite generally being converted to 60 cycles, all high-torque induction meters ordered for use on 125-cycle systems are provided with means for immediate reconnection for 60-cycle service, to provide for a possible future change. Meters ordered for 60-cycle service, however, are not provided with this feature, as it constitutes in that case an unnecessary complication.

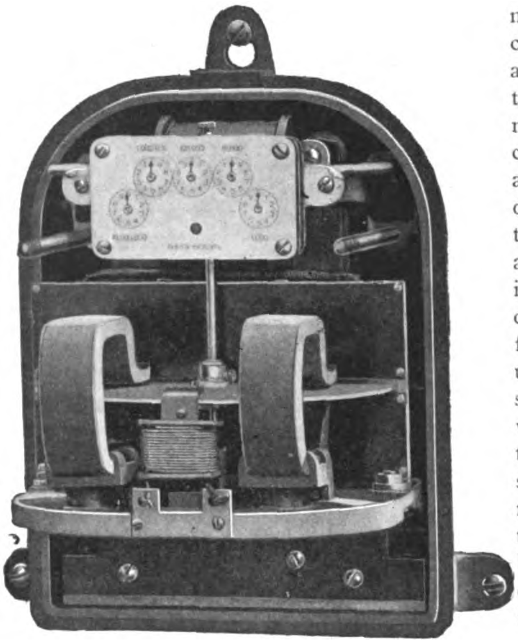

FIG. 1.—VIEW OF METER MECHANISM.

It is probably not generally appreciated that the principle of the induction meter renders it especially sensitive to variations of wave form, but great care has been exercised in the design of the high-torque meter to secure satisfactory behavior in this particular.

A large proportion of central-station systems of moderate size have appreciable variation of potential from the normal potential of the system, either on different portions of their lines or during different portions of the 24 hours. It is ,therefore, highly important that the meters used on such a system should be accurate irrespective of such potential variations. This characteristic may readily be determined by test. The high-torque meter is said to be unaffected by a 10 per cent. variation in voltage on either side.

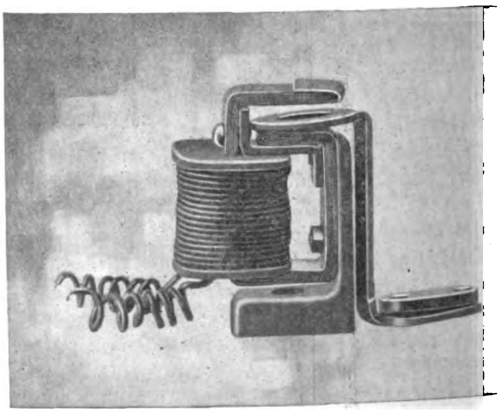

FIG. 2.—DEVICE FOR PRODUCING TORQUE.

New Apparatus and Appliances

THE AMERICAN OIL FILTER.

A new oil filter which has just been placed on the market by the Burt Manufacturing Company, of Akron, Ohio, is shown by Fig. 1. Our readers are already familiar with the great possibilities for economy which are afforded by the collection of waste lubricating oil, and filtering it over and over until it has been entirely used up. The saving in this way amounts to from 50 to 90 per cent., depending upon how carefully the oil is collected after having been used. This is an economy which is not generally overlooked in large plants, but is often neglected in plants using very little oil. The filter has been especially devised for filtering very heavy grades of oil which cannot be successfully cleaned in an ordinary filter because of the liability to clog up easily. The claim is made that such oils are readily purified by this filter, and that it will give equally good service with the ordinary engine oil. Referring to the illustration it will be noticed that the pan for receiving the oil is surrounded with a hot water chamber, through which a steam coil passes. When this chamber has been filled with water, and the lower part of the filter has also been filled with water until it flows from the faucet 2, the filter is ready for operation, the proper steam connections, of course, having been previously made. The cleansing of the oil is then accomplished as follows: Through the filtering material in the cylinder the oil makes its way into tube *B* and down onto the filter plate *D*, where the pressure of the oil above overcomes the resistance offered by the weight of the water, and the oil spreads out in a very thin film, becoming thinner and thinner, as it travels from the center to the circumference of the plate. Every particle of the oil is thus exposed to the action of the water. This process is repeated as the oil flows upon plates *D* 1 and *D* 2. The separation of every foreign ingredient from the oil is said to be thus made complete. The remaining impurities settle by force of gravity to the bottom of chamber *E*, and are drained off by simply opening the valve, the pure oil being drawn from faucet 1. Attention is called to the minimum of attention required by this filter. Any kind of filtering material may be used, or none at all, and the filtering material may be removed without interrupting the oil service. The method of cleaning the filter is very simple, requiring only that the cylinder at the top be unscrewed, the filtering substance removed and the sediment pan lifted out and emptied of the large quantity of dirt and grit which has collected in it through force of gravity. In nearly all other oil filters the bulk of the dirt is collected at the bottom—in the filter under discussion it is collected at the top, greatly increasing the ease with which the latter may be cleaned.

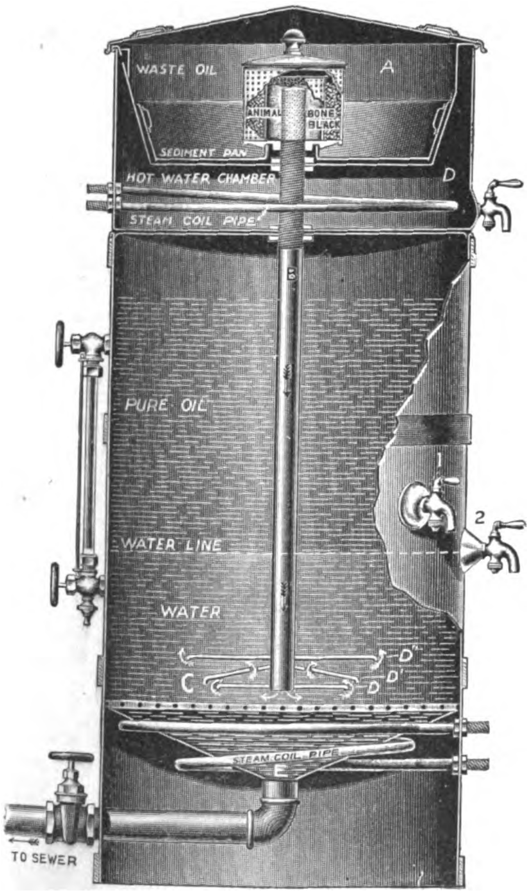

FIG. I.—AMERICAN OIL FILTER.

CAR-TYPE AUTOMATIC CIRCUIT-BREAKER.

The protection of railway motor equipments by the use of a fuse has until recently been the standard practice and recommendation of electrical manufacturing companies. The results obtained have been satisfactory only to a limited degree, as the fuse frequently fails to blow at the proper time, or to give the equipment the best protection under all conditions of service. The necessity of carrying extra fuses, as well as the inconvenience of stopping the car to replace a blown out fuse is more or less of an objection to this method, and many of the largest street railway companies have replaced the fuse block with the automatic car circuit-breaker. This practice offers better protection to the equipment, as it reduces to a minimum the possibility of injury to the apparatus arising from the carelessness of the motorman in improperly cutting out resistance—the circuit-breaker will open automatically when the current reaches the value for which it is set.

Aside from the protective feature of a circuit-breaker, the convenience in re-setting it, is obviously of great value. The motorman in throwing the handle of the breaker after the occurrence of a heavy overload or short circuit, is not required to leave his position at the controller to put the car in service. In most cases it is not necessary to stop the car, as the breaker can be re-set while drifting.

The automatic car circuit-breaker manufactured by the Westinghouse Electric and Manufacturing Company performs the function of the fuse block by opening an overload or short-circuit; it also replaces the platform or canopy switch, in that it provides a means for opening the circuit manually. In construction the instrument is thoroughly fire-proof, of the best material and workmanship throughout, and all parts are interchangeable. Its design prevents any arcing at the current-carrying contacts, as the arc is broken on extra contacts especially provided for the purpose, and assisted by a powerful magnetic blow-out which will open the severest short circuit without damage. The breaker is calibrated, and can be set to open at any current within the limit of its range. The automatic opening device insures absolute certainty in opening when the current reaches the predetermined value—a feature not found in any latch device, particularly if it is exposed to such weather conditions as are found in the vestibule of a street car.

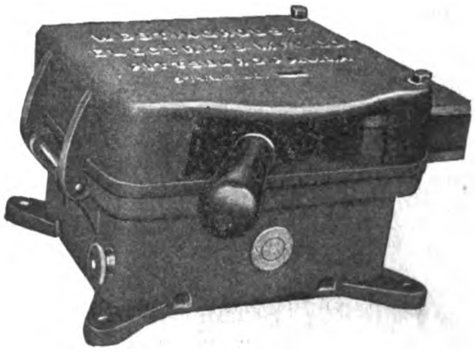

FIG. 2.—CAR-TYPE CIRCUIT-BREAKER.

WATER-PROOF FLOOR OUTLET BOX.

Fig. 3 herewith shows the Fullman water-proof floor outlet box, a section of which has been cut away so as to reveal the interior. The complete box is made up of four principal parts: a cylindrical cast-iron body having an expanded and deeply grooved rim at its upper end; an extension ring for adjusting the box to the level of the floor; a brass floor plate which is screwed to the extension ring, and a brass nozzle which screws into the floor plate and serves to protect the wires leaving the box. When installing the boxes, the cast iron body is placed about one inch below the floor level. After the finished floor is laid a 4½-in. hole is bored in the plank, central with the box below. The extension ring is then suspended in the

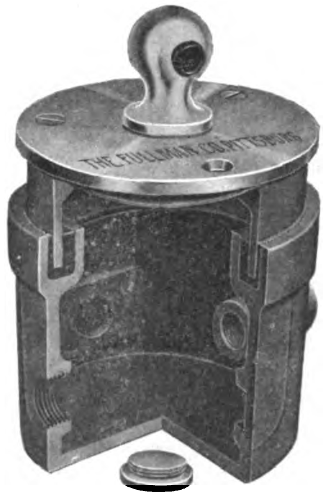

FIG. 3.—FULLMAN OUTLET BOX.

groove, being held in position by a template. A special compound is then poured into the groove, thus securing the ring and making at the same time a water-proof joint. The brass floor plate is then screwed into place with a rubber gasket, so as to make this joint also water-proof. Where the floor is of marble or stone, a brass ring is set in the floor to receive the floor plate and prevent the chipping of the marble. In adjusting, this ring is fastened to the extension ring, and both are set together by the template. The outlet nozzle for the cord is of solid brass, screwed into the center of the floor plate, a soft fiber washer keeping the joint water-tight. The nozzle is insulated with tough fiber tubing fastened to the nozzle by a screw so that it cannot be easily knocked out or broken off. The other features of the box are clearly shown in the engraving. All parts are interchangeable and the extension rings may be had in different sizes in order to accommodate the box to any height of floor. The outlet box is made by The Fullman Company, of Pittsburg, Pa.

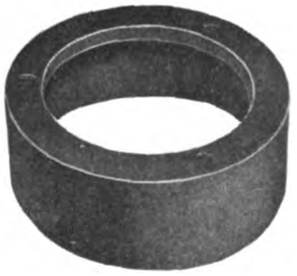
FIG. 4.—EXTENSION RING.

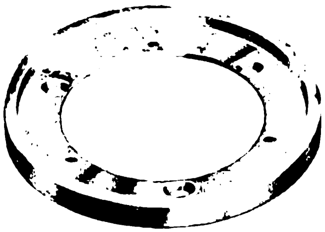
FIG. 5.—RING FOR MARBLE FLOOR.

NEW RECEPTACLE AND PLUG.

Fig. 6 herewith illustrates a new plug and receptacle for temporary connections, such as fan motors, desk and piano lamps, etc., which has several points of novelty. The manufacturers claim that it contains few parts, and that its simplicity renders it exceedingly strong and efficient. There is no projecting sharp edge when the receptacle is in use, and it presents a finished appearance with the plug in or out, as may readily be seen from the illustration. It can be wired from the back, and the wires drawn taut, exactly as in a flush or push button switch, and ample room is provided in the cap for the new code cord. This receptacle is known as the 1903 model, and is manufactured by the Marshall-Sanders Company, of Boston.

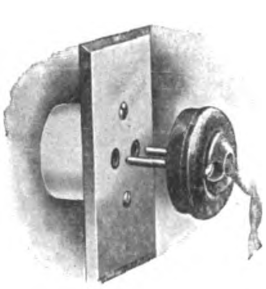
FIG. 6.—RECEPTACLE AND PLUG.

THE CORLISS ENGINE STOP.

The safety afforded by the equipment of engines with some sort of safety stop is too well known to require any extended comment. It would be difficult to find a modern plant where such a provision is not made. We have on various occasions illustrated and described the various engine stops on the market, and show herewith the latest type of the Corliss engine stop made by the Consolidated Engine Stop Company, of New York City. The stop, which is shown by Fig. 7, is designed for use in those cases where it is desirable to have the stop apply directly to the governor instead of to the valve. While differing in mechanical construction from other stops, it is, like them, operated automatically and accomplishes the same end. The machine consists of three parts—a cylinder attached to the governor column; a valve for admitting steam to the cylinder, with an electromagnet for releasing the valve, and a speed limit. Referring to Fig. 7, the valve *k* is held closed by the armature *g* of the magnet *o*. When the circuit *pp'* is closed, the movement of the armature releases the lever *h*, which in turn releases the valve *k*, allowing the steam to enter the cylinder *a* and force the piston *c* upward. A clamp *d* attached to the side rod *m* is thus engaged and raises the governor balls *nn'* to their highest position. They are held there by the check valve *l*, thus preventing the grab hooks from opening the main valves. By simply replacing the lever *h* and opening the valve *i*, the governor is allowed to slowly settle to its normal position. It is then only necessary for the engineer to rock the wrist plate forward and backward to set the valves in the proper position to admit steam, and the engine is again ready to start.

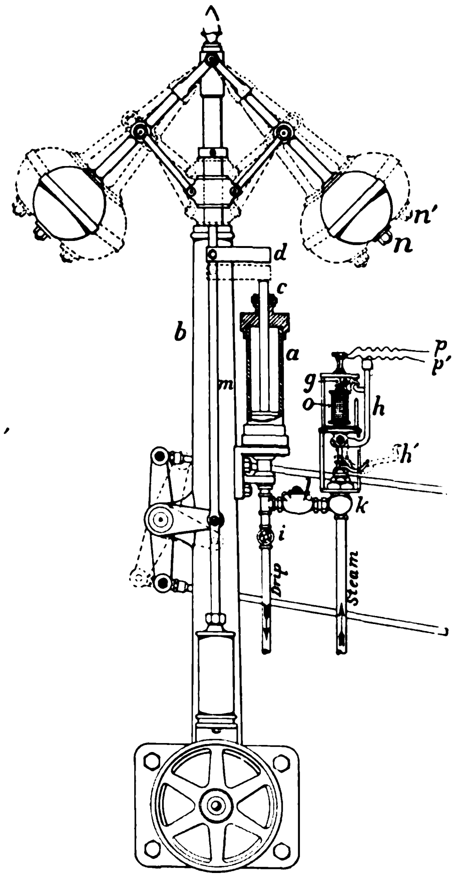

FIG. 7.—CORLISS ENGINE STOP.

VILLARD DOUBLE-GRIP CABLE HANGER.

Figs. 8 and 9 show the Villard cable hanger marketed by J. S. Barron & Co., of New York City, which is suitable for any size of cable. The hook and grip are made of one piece of galvanized steel wire and the strap is made of zinc. In applying the hanger it is held in the left hand with the strap resting against the cable, and the hook turned back. The free end of the strap is then passed under the cable and through the grip, as shown by Fig. 8. The strap is then pulled taut and the hook pulled over to the position shown by Fig. 9. The raising of the hook to this position obviously causes the grip to firmly bind and lock the hanger about the cable. The operation is exceedingly simple and rapid. The hanger is made in six sizes, ranging from 4 to 10 ins., capable of taking cables ranging from ¾ in. to 2 ins. in diameter.

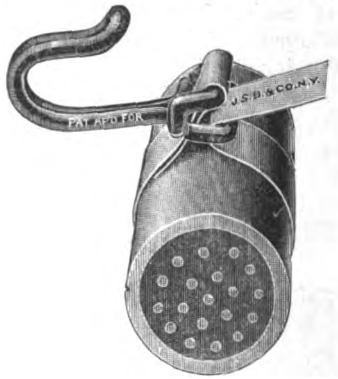

FIG. 8.—VILLARD CABLE HANGER.

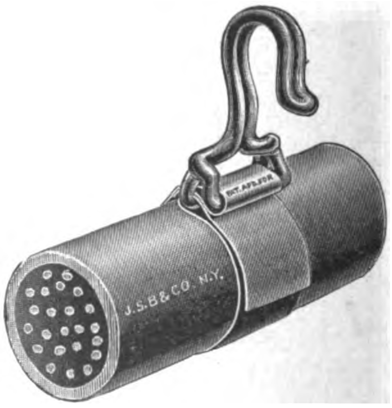

FIG. 9.—VILLARD CABLE HANGER.

METER WITH PREPAYMENT ATTACHMENT.

The accompanying illustrations show a new prepayment meter brought out by the General Electric Company. It consists of a prepayment device, which is electrically connected to a wattmeter, but which is, at the same time, mechanically independent. Although the meter with which it is used differs from the standard meter only in the construction and arrangement of the recording train and other minor details, the prepayment device is not applicable to Thomson recording wattmeters which have been purchased separately. The meter register is provided with a short-circuiting commutator which communicates with the prepayment device through a simple electric circuit, shown by Fig. 12. The prepayment device consists of a registering wheel which is normally disconnected from the handle, but which can be connected by the introduction into the receiving slot of a coin of proper denomination. When so connected the handle can be thrown so as to set the registering wheel of the prepayment mechanism forward one notch. If the circuit is open when a coin is deposited, the same motion of the handle which sets forward the registering wheel closes the circuit switch contained within the case of the device. A portion of the registering wheel is visible through the glass in front of the cover, and plain figures on the rim of this wheel, as shown by Fig. 11, indicate the number of coins remaining to the credit of the depositor. When the first coin is deposited and the handle moved, closing the main switch, the figure "1" is brought into view. If a second coin be deposited before the current purchased with the first coin has been consumed, a second motion of the handle will bring the figure "2" into view. Twenty coins can thus be deposited consecutively, and, as the device is designed for dimes, prepayment can be made for $2 worth of electrical energy at one time, after which the slot is automatically closed and further prepayment cannot be made until the value of one or more coins has been consumed. Whenever 10 cents' worth of energy has been delivered through the meter, a small amount of current is momentarily sent through the electromagnetic mechanism of the prepayment device which turns the wheel back one number. This process continues until all the energy for which prepayment has been made has been delivered, and the depositor can ascertain at any time how much energy can be obtained without further prepayment by looking through the glass window of the device. When all the energy has been delivered, the registering wheel moves back to the first notch, and opens the switch so that no more current can be obtained until further prepayment has been made. The indicating mechanism shows only the number of coins which stand to the credit of the depositor, but the dial of the meter may be consulted to determine what fractional part of the value to be canceled next is credited. The dial of the meter always indicates the amount of energy delivered, and thus serves to check the indications of the prepayment device. The use of a dial both on the prepayment device and on the meter is an important feature, since it serves to show at once any discrepancy between the record of the meter dial and the number of coins deposited in the receiver. The switch is of the double-pole, double-break type, and has clips and blades of ample size. It is designed to open successfully, and without injury to itself, a circuit carrying current up to the amount of the maximum overload allowable for the largest meter with which the device can be used. The closing and retaining mechanism of the switch is positive in its action, and both strong and simple in construction. Every precaution has been taken to guard against cheating. A coin or washer larger than the coin for which the device is designed cannot be introduced into the receiving slot, and a smaller one will not operate the device. A coin having a thread or wire attached passes through the mechanism and unlocks it, but the motion of the actuating handle cuts off the thread or wire so that the coin passes into the receiving box and cannot be withdrawn, and the intended fraud is detected when the coin receptacle is opened. The coin receptacle is detachable and may be sealed at the company's office, and the collector intrusted with simply removing it and replacing it with an empty one.

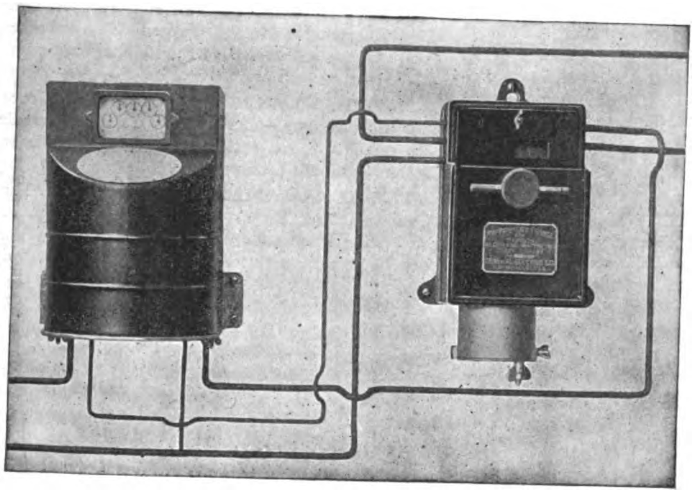

FIG. 10.—METER WITH PREPAYMENT DEVICE.

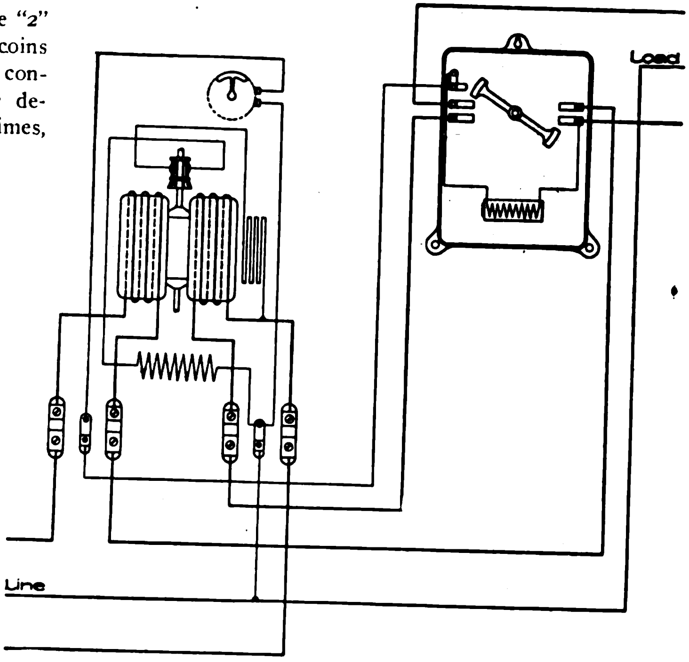

FIG. 12.—DIAGRAM OF CONNECTIONS.

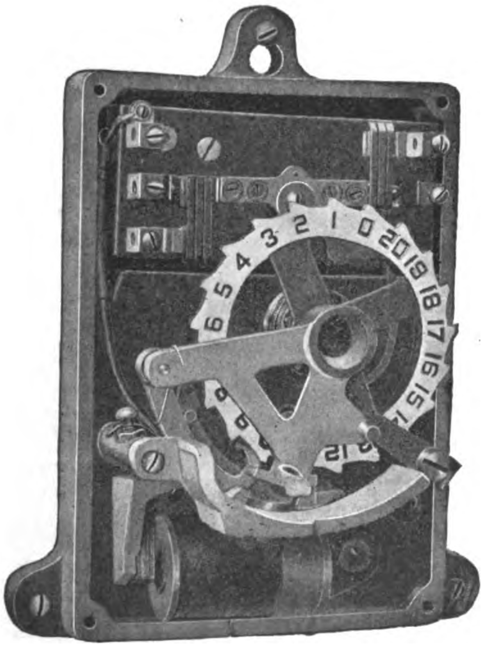

FIG. 11.—INTERIOR OF PREPAYMENT DEVICE.

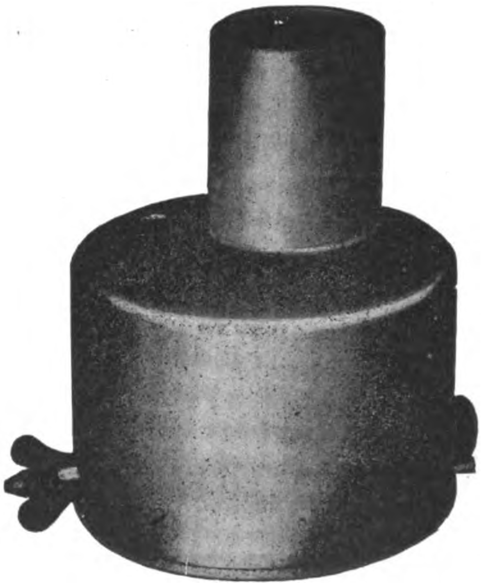

FIG. 13.—COIN RECEPTACLE.

NEW BOOKS.

Practical Electricity. By J. C. Lincoln. (Third edition.) Cleveland, Ohio: Cleveland Armature Works. Leather; 449 pages, 4 x 6 ins.; 87 illustrations. Price, $2.00.

This edition of Mr. Lincoln's little book contains considerable additional material over the previous edition, and the old material has been revised to some extent. Most of the subject matter is fairly well handled, although some of the elementary explanations are simplified beyond the limits of accuracy; for example, the statement that the depolarizer in a battery "burns up the hydrogen," is somewhat strained. As the book is intended for practical workers, who would naturally carry it around and handle it a great deal, it is a pity that the binding is not more substantial.

Alternating-Current Machines. By Samuel Sheldon and Hobart Mason. New York: D. Van Nostrand Company. Cloth; 264 pages, 5 x 8 ins.; 184 illustrations. Price, $2.50.

This is the companion book to Dr. Sheldon's "Dynamo Electric Machinery," and a worthy mate to that excellent work. The present book is notable chiefly for directness of exposition—the crisp conciseness with which principles and theories are stated and explained; no words or time are wasted. Barring a few expressions that might be classed as technical colloquialisms, the book is thoroughly commendable for the use of well-grounded students. Among the rather objectionable expressions are references to e.m.f.'s and curves as being "at right angles to each other," and the use of the word "field" when a field magnet is meant. Another minor cause for criticism is the use in some places of the term "log" to indicate a hyperbolic logarithm. The last line of Sec. 19, page 37, contains a typographical error in the word "elastic," which was evidently intended to read "electric." This class of errors, however, is unusually scarce for a first edition.

The explanation of self-induction is the only absolutely self-contained clear one we have ever seen in print, and the discussion of condensers and capacity is similarly excellent. An especially useful part of the book is the chapter of Problems, which will be found welcome for reference purposes by the most advanced students as well as instructive by those on the lower rungs of the alternating-current ladder. A commendable feature of the section on tests is the use of a consistent system of diagrammatic symbols by means of which tedious and digressive explanations of the figures in the diagrams are obviated. The book will not be found greatly helpful by non-mathematical readers, and was not intended for such; for others, it should prove valuable.

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PERSONAL.

MR. HENRY L. SHIPPY, of John A. Roebling's Sons Company, has returned from a trip to London, where he attended the coronation of the king.

MR. L. G. VAN NESS, formerly of the Denver Gas & Electric Company, has accepted the position of general manager of the Gas & Electric Company of Lincoln, Neb.

MR. ANDREW PINKERTON, electrical engineer for the American Sheet Steel Company at Vandegrift, Pa., was married recently to Miss Elizabeth McCauley, of Apollo, Pa.

MR. DANIEL HEMENGRAY, of the Hemengray Glass Company, Covington, Ky., is making a trip through Europe, from which he will return to this country within the next week or ten days.

MR. A. H. BERRY, for several years manager of the electrical department of the H. W. Johns Company, has resigned his old position to accept the general managership of F. H. Lovell & Co., New York.

MR. P. M. FLETCHER, recently of the New York staff of the Western Electric Company, has resigned his position there to accept a responsible post with the Burnett Company, of New York, dealers in electrical supplies.

MR. C. P. PLATT, of the sales department of the Kellogg Switchboard & Supply Company, Chicago, at the time of writing is ill with typhoid fever. Mr. Platt has the sincere condolence of the American Electrician and a host of other friends.

MR. GEO. F. BROCKMAN, formerly superintendent of the Cold Spring (N. Y.) Light, Heat & Power Company, has resigned his position with that company to accept the superintendency of the electrical department of the Newton Gas & Electric Company, Newton, N. J.

MR. THOS. B. WHITTED, formerly manager of the sales department of the General Electric Company's branch office at Denver, Colo., recently resigned his position there to assume technical charge of the J. J. Henry enterprises, which include gas, electric light and power plants in a number of Western cities.

MESSRS. H. W. MORRIS and JOHN OBENBERGER, formerly connected with the Gibbs Electrical Company, Milwaukee, Wis., have established a manufacturing business of their own under the style of the M. & O. Company. The new firm has taken over a well-equipped machine shop in Milwaukee and engaged in the manufacture of dynamos and motors.

MR. CHAS. E. HEWITT, who has been for some time past the senior partner in the firm of Hewitt & Warden, Newburgh, N. Y., has disposed of his interests in that firm and organized an electrical engineering company under the style of C. E. Hewitt & Co., Inc. The new company will devote its attention chiefly to the construction of central stations and marine electrical construction.

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TRADE PUBLICATIONS.

SPRINGS. American Steel & Wire Company.—This is catalogue No. 5, devoted to an extremely comprehensive line of coil and flat springs for all classes of service.

AUTOMATIC CIRCUIT-BREAKERS. General Electric Company.—Bulletin No. 4,285, superseding Bulletin No. 4,194, and devoted to the well-known Type M. circuit-breaker.

THE HUNT CABLE RAILWAY. C. W. Hunt Company, New York.—This is catalogue No. 029, containing illustrations and descriptions of a number of typical Hunt installations, together with some interesting details of the apparatus itself.

DIRECT-CURRENT BELT-DRIVEN GENERATORS. General Electric Company.—Bulletin No. 4,288, superseding Bulletin No. 4,253, and devoted to slow and moderate-speed direct-current machines of from 6½ kilowatts to 85 kilowatts capacity.

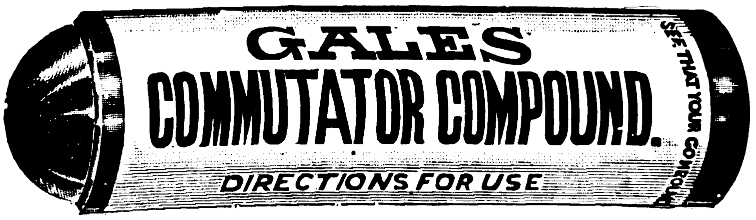
STEAM SPECIALTIES. Jas. McCrea & Co., Chicago, Ill.—A nicely executed catalogue of the well-known steam specialities manufactured by this company, among which may be mentioned the Climax steam joint clamp, H. H. steam trap and Butman flue cleaner rod.

VICTOR INSULATORS. Fred Locke, Victor, N. Y.—Catalogue No. 6, devoted to the well-known Victor porcelain and flint glass insulators, and containing in addition to the descriptive matter a long list of plants in which Locke insulators are used.

THE INDUCTOR ALTERNATOR. Stanley Electric Manufacturing Company.—Bulletin No. 28, containing a profusely illustrated description of the S. K. C. inductor alternator, together with supplementary remarks relative to the S. K. C. frequency changer, with an illustration of the machine.

SWITCHBOARDS, PANEL BOARDS AND PARTS. McKenna Bros. Brass Company, Ltd., Pittsburg, Pa.—A well-executed catalogue of standard size, containing illustrations and prices of tablet boards, knife switches and other switchboard appurtenances, including bus-bar fittings of all kinds.

A COMMUTATOR NECESSITY.



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IDEAL ENGINES. A. L. Ide & Sons, Springfield, Ill.—This is a beautifully illustrated catalogue of standard size, containing handsome half-tone illustrations of the well-known Ideal engines and all of the principal details of construction. Each part of the engine is fully described and its advantages pointed out.

THE RENOLD SILENT CHAIN GEAR. The Link-Belt Engineering Company, Philadelphia, Pa. —Bulletin No. 1001, in which is given an illustrated description of the Renold chain, together with descriptions of a number of installations in which this chain is used and a table of standard sizes, weights, working loads, etc.

INTERURBAN RAILWAY MOTORS. General Electric Company.—This is bulletin No. 4294, in which is illustrated and described the GE-73 railway motor, which was put on the market some time ago to meet the demands for heavy-duty high-speed equipment for interurban service. The bulletin is well illustrated and the data is exceptionally complete.

ELECTRIC PUMPING MACHINERY. General Electric Company.—This is publication No. 1039, and is one of the handsomest that the General Electric Company has ever issued, which is saying a good deal. It is larger than the average trade publication, measuring 8x10½ ins., and contains illustrations and descriptions of an enormous variety of electrically-driven pumps.

SWITCHBOARD AND CONDUIT FITTINGS. Frank H. Stewart & Co., Philadelphia, Pa.—Catalogue No. 10, containing illustrations, dimensional data and prices of push-button switch mats, round-switch blocks and switch mats, round and square outlet boxes, combination boxes, steel push-button cases, outlet insulators, etc. The catalogue also contains illustrations and descriptions of plain and switch panel-boards.

HARDWARE SPECIALTIES. Smith & Hemenway Company and the Utica Drop Forge & Tool Company, New York.—This is the fourth edition of the well-known Green Book issued by these two associated companies, and is the handsomest edition thus far put out. The present book is considerably larger than previous editions and rather better executed typographically. It covers a tremendous range of hardware specialties entirely too great to attempt any enumeration.

DIRECT-CURRENT MOTORS. Northern Electrical Manufacturing Company, Madison, Wis.—Bulletin No. 29, which is profusely illustrated with excellent half-tone engravings and devoted to the well-known Northern multipolar direct-current motors. These machines are built in two styles, one having a single-piece field magnet casting and the other having the magnet poles bolted to the yoke-ring. The catalogue contains also illustrations of several notable installations of these motors.

ELECTRICAL TABLES. American Steel & Wire Company.—A book of convenient size containing tables of dimensions and weights of pure copper wire in B. & S. gauge, comparative sizes of the different gauges, comparative weights of the different gauges, resistances in B. & S. gauge, data as to stranded conductors, approximate weights of insulated electric light wires, diameter over insulation of magnet wires, and data relating to iron and steel wire. The book also contains illustrations of Crown and United States rail bonds, with directions for application.

TEST OF A 300-H.P. STEAM TURBINE. De Laval Steam Turbine Company, New York.—Bulletin No. 1, containing the full report of an exhaustive test made by Dean & Main, mechanical engineers, of Boston, with a 300-h.p. De Laval turbine driving two direct-current generators. A summary of the test shows a steam consumption of 13.94 lbs. per brake horse-power with superheated steam and a load of 352 horse-power, all of the nozzles being in use, of course. With saturated steam the maximum load was 333 horse-power and the steam consumption 15.17 lbs.

ELECTRICAL APPARATUS AND SUPPLIES. The George Worthington Company, Cleveland, Ohio.—This is a catalogue of large size, covering a tremendous range of electrical supplies, apparatus and machinery, such as first-class houses handle. Annunciators and other house goods, electric gas lighting apparatus, electric light switches, cut-outs, insulators, etc., enclosed arc lamps and globes, telephone and telephone equipment, direct-current dynamos and motors, indicating instruments and construction material, are included in the scope of the catalogue.

BRONX PARK. New York Central & Hudson River Railroad Company.—This is No. 14 of the "Four-Track Series" and is one of the most interesting pieces of advertising literature that have come to the reviewer's desk. It contains a good-sized map of Bronx Park, some excellent pictures of the inhabitants of the zoölogical portion of the park, and a convenient time table of trains between the Grand Central Station and the stations at Bronx Park. The Bronx Park Station proper is located at the entrance to the botanical gardens, while the Fordham Station is near the entrance to the zoological park. The illustrations of animal life in the zoölogical garden are accompanied by interesting descriptive matter.

◆◆◆

BUSINESS NEWS.

STANLEY & PATTERSON, of New York, are calling especial attention to their sound-proof telephone booths, which are claimed to be actually sound proof and not merely closets of ordinary construction.

THE STERLING ELECTRICAL MANUFACTURING COMPANY, Warren, Ohio, received this month United States letters patent covering the double-spiral anchored filament which is the feature of the Sterling "Special" incandescent lamp.

WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, Mo., reports that the demand for Adams-Bagnall arc lamps shows no signs of diminution, but is, on the other hand, increasing steadily. More than 100,000 of these lamps are now in use.

H. K. McCAY of the McCay Engineering Company, Baltimore, Md., is receiving many orders for his practical instruction cards. Mr. McCay states that a large exporter in London has negotiated for 1,000 sets of these cards for distribution throughout the United Kingdom.

EVANS & HOWARD FIRE BRICK COMPANY, St. Louis, Mo., is manufacturing an excellent glazed clay conduit for sheathing underground steam and hot water pipes. The glazed clay pipes are easily installed and practically indestructible. They are made with flange joints which are said to fit perfectly tight.

PETTINGELL-ANDREWS COMPANY, Boston, Mass., has been compelled by increase of business to secure larger quarters, and has accordingly arranged to occupy a modern six-story building at the corner of Pearl Street and Atlantic Avenue, which is being refitted especially to suit the company's purposes.

Telephone Service
Is the
Quickest Messenger.
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SOLID TRAINS TO NORTHERN MICHIGAN.

The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

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BIG STICK, 35 CENTS.
Sample Free.
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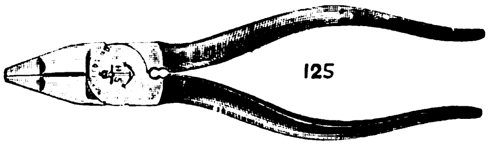
It will pay you to be put on our bi-monthly free mailing list. Shall we? Thanks, send your address



With or Without.
You can have the plyer with or without splicing clamp. If you take it with splicing clamp you get two tools in one. If you want it without splicing clamp ask for No. 115. Fully guaranteed. Try them.
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FOR INCANDESCENT LAMPS AND EVERYTHING ELSE.
BAKER & CO.
MANUFACTURERS OF PLATINUM IN ALL SHAPES.
Newark, N. J. New York Office, 120 Liberty St.

SMITH & HEMENWAY COMPANY, New York, has purchased the patents, good will, machinery, tools and plants of the Yankee Company, manufacturer of the Yankee nail puller and other specialties.

I. P. FRINK, New York, reports a continuation of the large business in reflectors which he has enjoyed for a long time. Special window reflectors have recently been sold to Bloomingdale Bros., the Siegel-Cooper Company, Saks & Co., and R. H. Macy & Co., all of New York City.

SUNLIGHT LAVA MANUFACTURING COMPANY, Chattanooga, Tenn., has acquired the plant, business, good will and rights of the Sunlight Acetylene Gas Burner Company, and will continue the manufacture of lava insulators and bushings, acetylene burners and gas burner tips.

WAGNER ELECTRIC MANUFACTURING COMPANY, of St. Louis, Mo., has been awarded the Edward Longstreth Medal of Merit by the Franklin Institute for a "meritorious contribution to science and industrial arts," consisting of its well-known single-phase alternating-current motor.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY has contracted with the Jessop Steel Company of England for a large equipment of direct-current machinery to be installed in a steel plant which the Jessop Company is building at Washington, Pa., in which electrical power distribution will be employed.

AMERICAN SCHOOL OF CORRESPONDENCE, Boston, Mass., which recently effected an alliance with the Armour Institute of Technology, as noted in these columns at the time, has decided to remove from Boston to Chicago in order to make the co-operation between the two institutions more feasible and complete.

F. H. LOVELL & CO., New York, announce that they are prepared to supply all kinds of insulating specialties, such as insulation for trolley wire fittings and specially molded insulation of all kinds for switch work, motor controllers, arc lamps, etc. The company also manufactures a full line of brass trolley wire fittings, trolley wheels, etc., supplies, enclosed fuses and fittings of all descriptions.

PITTSBURGH GAGE & SUPPLY COMPANY, Pittsburg, Pa., recently sold to the United Steel Company, Canton, Ohio, four 250-h.p. water-tube boilers and to the Ward-Mackey Company, Pittsburg, Pa., two boilers of the same size and type. The company is also installing a complete White Star filtering system in the power house of the New York & Stamford Street Railway Company at Port Chester, N. Y.

THE KELLOGG SWITCHBOARD & SUPPLY COMPANY, Chicago, Ill., has closed a contract with the Keystone Telephone Company, Philadelphia, Pa., for two more common-battery multiple-relay switchboards of 4800 lines capacity each. These boards will go in the fifth and sixth district exchanges of the Keystone Company, and will make the total ultimate capacity of the equipment thus far supplied by the Kellogg Company 34,080 lines.

THE OTIS ELEVATOR COMPANY reports orders received during a single week recently for 51 electric elevator outfits. The company recently received an order from the Manhattan Railway Company for four heavy-duty electric passenger elevators with magnet control, to be installed in the new elevated railway station at 110th Street on the west side. Each of these elevators will have a maximum capacity of 3300 lbs., and will run at a speed of 300 ft. a minute.

WESTINGHOUSE MACHINE WORKS is enjoying a brisk trade in gas engines. Recent contracts include an 85-h.p. vertical two-cylinder engine for the Zanesville (Ohio) Electric Company; a 125-h.p. vertical three-cylinder engine, direct-connected to a dynamo, for Kelly & Jones, Pittsburg, Pa.; an engine of the same size and type for the H. Garrison Foundry Company, Pittsburg, Pa., and a third engine of this size and type for the Mingo Junction (Ohio) Water Company.

THE ELECTRIC STORAGE BATTERY COMPANY has opened a number of Exide battery depots in different localities for the purpose of maintaining Exide automobile batteries in the best possible manner and at the same time sparing the users the trouble and expense of shipping the batteries to the factory. Users of the Excite battery are requested to consult with the engineer in charge of the nearest battery station when desirous of securing advice or new parts for their equipment.

THE DICKEY-SUTTON CARBON COMPANY, Lancaster, Ohio, was recently incorporated with a capital stock of $100,000 for the purpose of manufacturing a general line of carbon products, including carbons for open and enclosed arc lamps, carbon brushes, telephone transmitter carbon, dry battery carbons, etc. The officers of the company are as follows: H. M. Sutton, president and treasurer; Edmund Dickey, vice-president and general manager; S. S. Wilson, secretary, and Robert Dickey, superintendent. The company expects to have its plant in regular operation about December 1.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY is hard pressed with orders, as usual. Among recent interesting contracts were the following: A 250-kw. two-phase 440-volt alternator with 20 Type C induction motors, 38 Type O. D. transformers and a number of arc and incandescent lamps, for the Illinois Glass Company; two 375-kw. alternators, one 400-kw. direct-current dynamo and a 300-kw. rotary converter to be used as a connecting link between the alternating and direct-current generators, also about 50 induction motors to be used for driving machine tools; this equipment for the new plant of the Standard Steel Car Company.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY recently closed a contract with the Syracuse (N. Y.) Railroad Construction Company, which is building a 25-mile line between Auburn and Syracuse, for two 650-kw. three-phase alternators, five 400-kw. rotary converters, the necessary step-up and step-down transformers and a complete switchboard equipment. The alternators will generate current at 360 volts and 25 cycles, and will be direct driven by two 22 and 44x48 in. cross-compound horizontal Corliss-type engines, which will be supplied by the Westinghouse Machine Company. These engines will run at 100 r. p. m., and are rated at 1000 horse-power each, with a maximum ability of 1800 horse-power. The generator current will be raised to 15,000 volts for transmission to two sub-stations.

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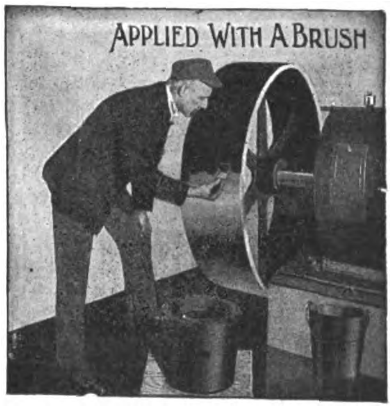

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American Electrician.

Vol. XIV. New York, November, 1902. No. 11.

ELECTRICAL EQUIPMENT OF A LARGE HAT FACTORY.

POWER PLANT OF THE JOHN B. STETSON COMPANY.

The extensive hat manufacturing plant of the John B. Stetson Company at Philadelphia, Pa., is equipped throughout with the most modern machinery, and the installation represents approved practice in the arrangement of manufacturing establishments. With few exceptions the entire plant, covering a floor space of over ten acres, is electrically driven. Wherever it is possible, an independent motor drive is employed in preference to a belt drive; but in many instances small machines are advantageously grouped together and driven from a single countershaft. In cases where absolute cleanliness is essential, as, for instance, in the operation of the silk looms where a drop of oil might ruin the fabric, each loom is coupled directly to a small motor.

Four double-deck tubular boilers made by the Coatsville (Pa.) Boiler Works and nine others of different makes furnish the steam supply of the plant at a pressure of 80 lbs., and provision has been made for a future battery. A battery of two of the Coatsville boilers is now being fitted with a Murphy mechanical stoker, which will burn bituminous coal; all of the others are hand-fired with anthracite pea coal. Fig. 2 is a view of the old boiler room, the new boilers being in a room on a line with and directly adjoining the boiler room shown in the engraving.

The power equipment in the main engine room comprises three engine-type generating units, one 35-kw. engine-type unit and one 25-kw. direct-driven unit. Each main unit consists of a 350-h.p. 24-in. x 48-in. engine running non-condensing and coupled to a 200-kw. Crocker-Wheeler direct-current generator. The main engines were built by C. H. Brown & Co., of Fitchburg, Mass., and are provided with their heavy-duty tangye frame. They are of the firm's standard four-valve releasing gear type with gridiron admission and exhaust valves operated by sep-

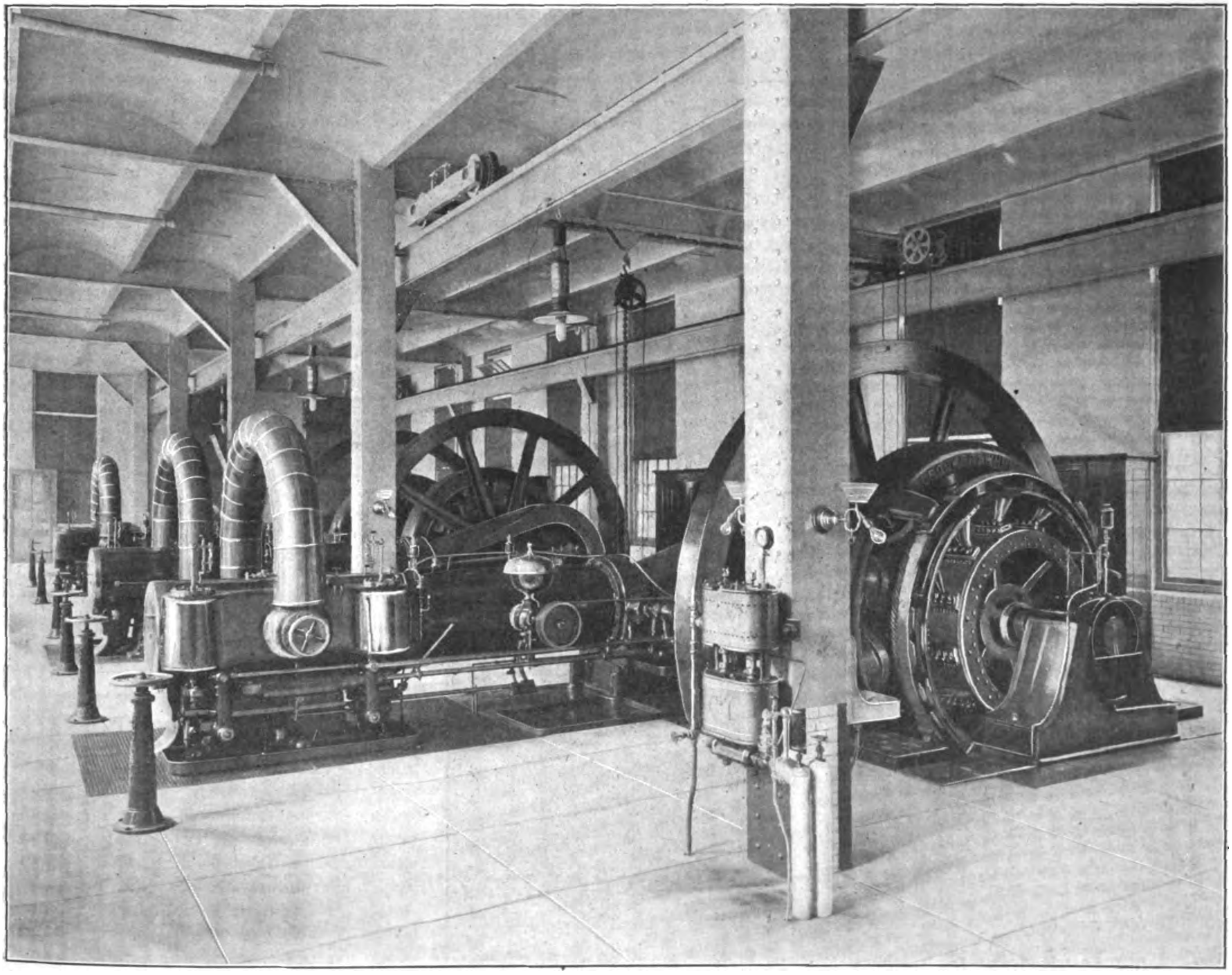


FIG. I.—VIEW OF MAIN GENERATING UNITS IN THE ENGINE ROOM OF THE J. B. STETSON COMPANY.

arate eccentrics. Each engine is guaranteed to develop not less than 345 horsepower at ¼ cut-off and a speed rate of 90 r.p.m., with a steam pressure of 75 lbs. at the engine throttle and exhausting against a back pressure of 3 lbs. in addition to the atmospheric pressure. The cylinders are provided with automatic relief valves of ample size, and the speed is guaranteed by the builders not to vary more than 2½ per cent between full load with a steam pressure of 75 lbs. and no load with a steam pressure of 100 lbs., exhausting free into the atmosphere.

Probably the most distinctive feature of the Brown engine is the valve gear. The admission valves work on vertical seats, while the exhaust valves are placed horizontally immediately below the bore of the cylinder. The valves are held in bored recesses provided for them in the body of the cylinder and are located very close to the bore in order to reduce the clearance as far as practicable. The steam valves have a very short motion resulting in a full port opening very early in the stroke, and maintaining the steam pressure with a very slight fall from that at the throttle. The admission valves are operated by the eccentric rod through bell cranks. The valve is lifted until tripped by the action of the governor, when it closes quickly under the action of gravity. No springs or vacuum pots are provided, the down stroke being cushioned by an air dash-pot. The exhaust valves are connected to a sliding bar on the front of the cylinder through links and bell-cranks on vertical axes, which cause the valves to slide across the bore of the cylinder in response to the reciprocating motion of the bar. The effect of the bell-crank angle is to open the valves quickly at the beginning of the exhaust and to hold them fully open until the stroke is nearly completed, only closing them in time to provide the necessary compression. This results in a free exhaust and also serves to quickly relieve the cylinder of any water which may enter, the exhaust ports being located at the bottom of the cylinder and being of ample area.

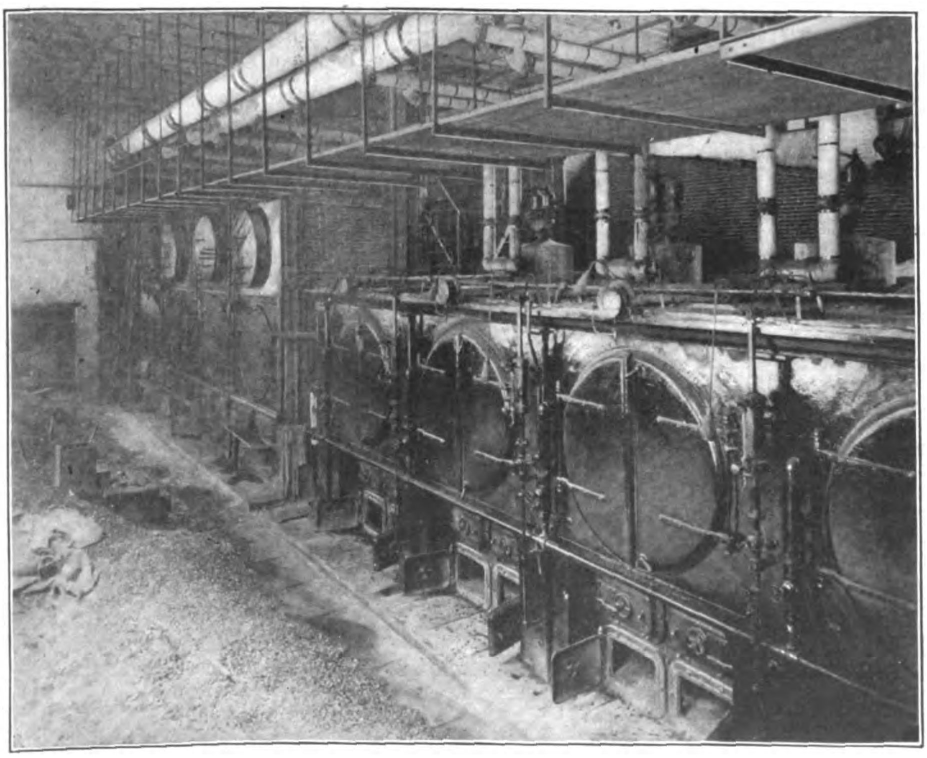


FIG. 2.—VIEW OF OLD BOILER ROOM.

All of the engines are lubricated by an automatic arrangement devised by J. E. Lonergan & Co., of Philadelphia. The oil is supplied by gravity from an overhead reservoir through brass pipe, which is nickeled wherever it shows above the floor. Each bearing has its own individual feed and adjustment, according to the requirements of the bearing. In addition, an independent cup feed is provided for each bearing so that if the automatic supply should fail, recourse may be had to this system of lubrication. All of the oil drips are collected, passed through a separator and led to a large oil filter in the basement of the engine room. A small air pump made by the New York Air Brake Company and shown in the foreground of Fig. 1 supplies the requisite air pressure for lifting the oil from the filter to the tank in the engine room, and also supplies compressed air for blowing off any accumulation of dust from the generators.

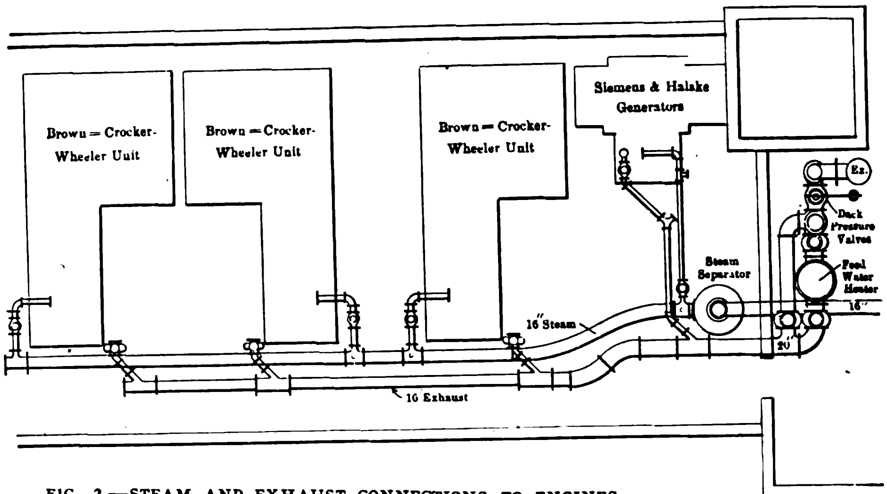

Brown = Crocker-Wheeler Unit
Brown = Crocker-Wheeler Unit
Brown = Crocker-Wheeler Unit
Siemens & Halske Generators
Ex.
Back Pressure Valves
Steam Separator
Feed Water Heater
16″
20″
16″ Steam
16 Exhaust

FIG. 3.—STEAM AND EXHAUST CONNECTIONS TO ENGINES.

Amer. Elec.

Diagrams of the steam and feed-water piping, which was installed by S. Faith & Co., of Philadelphia, are given by Figs. 3 and 4. The boilers feed into duplicate mains and are fitted with the requisite valves for cutting any of them out of circuit in case of mishap. The connections to a Greene engine (located in another room) and to the auxiliaries are clearly indictated in Fig. 4 and require no explanatory comment. All of the piping to the new engines is located in the basement beneath the engine room. Steam is supplied through a 16-in. main which, after passing through the partition wall, connects with a steam separator and a copper bend for taking up the expansion. Steam connection to the engines is made through long-sweep bends, as shown in the front page illustration. Each bend is provided with a lagging of cork covered with Russia iron. The valves, which are of Chapman make, are operated through the medium of hand wheels set on pedestals on the floor directly in front of the engines.

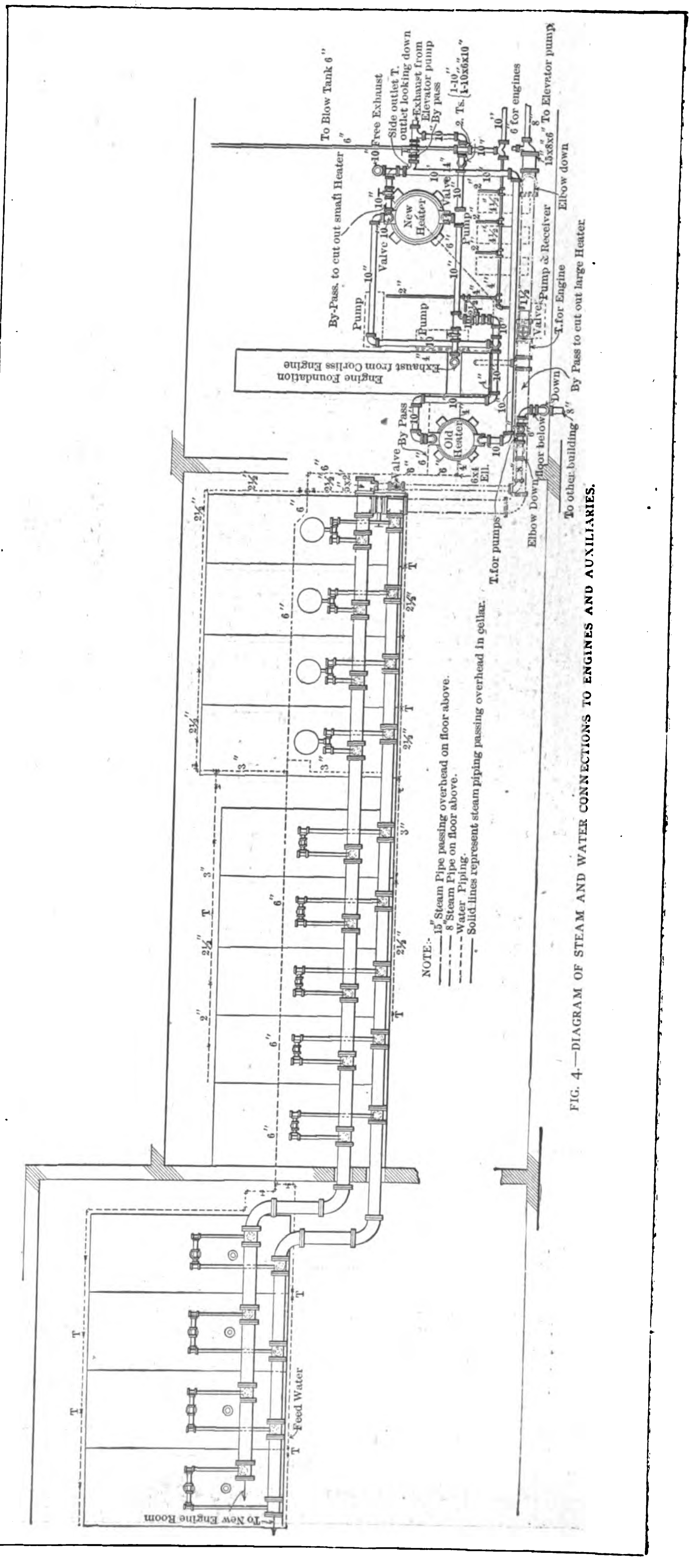
All of the engines, with the exception of the Greene engine, exhaust into a single 16 to 20-in. cast-iron main extending the length of the engine room basement and discharging to the atmosphere through a back-pressure valve after passing through a Berryman feed-water heater. The latter is by-passed so that if expedient it may be cut out of the exhaust steam line without interfering with the operation of the plant. Exhaust steam is used throughout for heating purposes and live steam is utilized in some of the manufacturing processes, an 8-in. main from the boilers supplying the steam to the other buildings than that in which the boilers are located. The feed-water is taken from a duplicate set of connections with the city water mains and after passing through the pumps it circulates through an auxiliary heater supplied with exhaust steam, whence it passes to the boilers.

The Crocker-Wheeler generators are compound-wound machines giving a terminal e.m.f. of 250 volts when driven at a speed of 90 r.p.m., and embody the well-known features of the engine-type generators made by that company. They are so wound that by means of the shunt field rheostat it is possible to vary the e.m.f. by 20 volts at any load. The stipulated regulation calls for an inherent variation of not more than two volts with 50 per cent. of the load thrown suddenly on or off. This variation includes the speed margin allowed under the engine guarantee; that is, considering the generator and engine as a single unit, the voltmeter must not show a deflection of more than two volts from its position when 50 per cent. of the load is suddenly added or taken off. The efficiency of the generators at ¼ load is 83 per cent.; at ½ load, 90 per cent.; at ¾ load, 93 per cent., and at full load 94 per cent.

The 35-kw. unit consists of a New York Safety Steam Power Company's engine driving two Siemens & Halske external-commutator generators, one at each end of the shaft; it is not used now in regular operation. The other unit consists of a Westinghouse engine and a Quaker City dynamo. This latter unit is used on Sundays to supply light in a Sunday-school conducted by Mr. Stetson and also to run a motor driving the bellows of a pipe organ. In a room adjoining the boiler room is a 350-h.p. Greene engine, the cylinder of which is 22-ins. x 48-ins.; this engine runs non-condensing and drives, through belting and shafting, machines in the forming mill, blowing mill and tip stretching departments and the machine shops.

The switchboard, a view of which is given by Fig. 9 herewith, was constructed and installed by the Walker Electric Company, of Philadelphia. It is made of 1½-in. blue Italian marble, which resembles the Rutland (Vt.) marble so commonly used for switchboards, but which is much heavier and of a closer grain. The board is built on the unit principle; that is, a panel is provided for each dynamo and a combined lighting and power panel for each of the buildings occupied by the Stetson Company. The switchboard at present is 20 ft. long and contains ten panels, but two panels will be shortly added. Five of the panels control as many generators; two panels are used for the junction switches and instruments to measure the total output of the plant, and the last three panels at the right control three lighting circuits and as many power circuits, which run to three buildings.

The instruments are Weston, of the illuminated-dial type, set flush with the face of the marble; the circuit-breakers are of the well-known Cutter laminated type, and the recording instruments are of Bristol manufacture, excepting the General Electric watt-hour meters. The two voltmeters, mounted on swinging brackets at the end of the switchboard, are controlled by two voltmeter switches, which are so cross-connected on the center panel of the board that the voltage of any generator or either of the two sets of bus-bars may be read on either voltmeter. The voltmeter on the center panel is calibrated in ohms as well as volts, and is controlled by the voltmeter switch directly under it. This switch is so con-


To Blow Tank 6"
By-Pass to cut out small Heater
Pump
Valve
New Heater
Free Exhaust
Side outlet T. outlet looking down
Exhaust from Elevator pump
By pass
6 for engines
To Elevator pump
15x8x6
Elbow down
Pump & Receiver
T. for Engine
By Pass to cut out large Heater
Engine Foundation
Exhaust from Corliss Engine
By Pass
Old Heater
Down
floor below
To other building
Elbow Down
T. for pumps
6x4 Ell.
Feed Water
To New Engine Room
T

NOTE:-
—— 15" Steam Pipe passing overhead on floor above.
— — 8" Steam Pipe on floor above.
-·-·- Water Piping.
Solid lines represent steam piping passing overhead in cellar.

FIG. 4.—DIAGRAM OF STEAM AND WATER CONNECTIONS TO ENGINES AND AUXILIARIES.

nected that grounds can be detected on any of the four main bus-bars of the board. Lights, showing through red glasses mounted flush with the face of the board, indicate which of the generator panels is alive, and the same is true of the

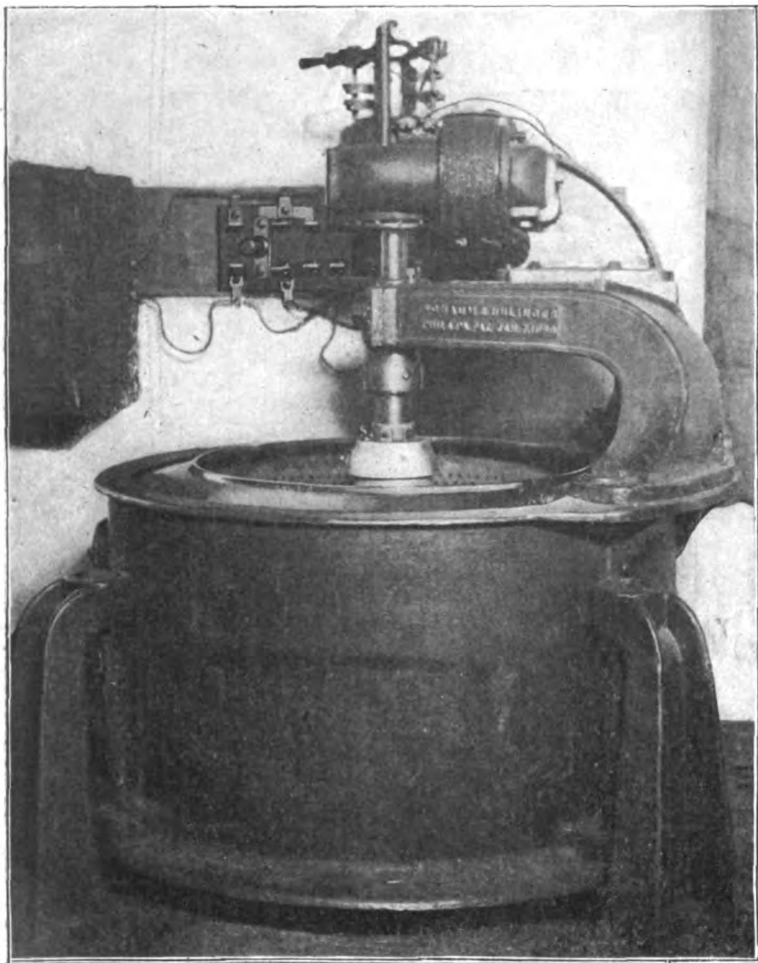


FIG. 5.—MOTOR-DRIVEN WHIZZER.

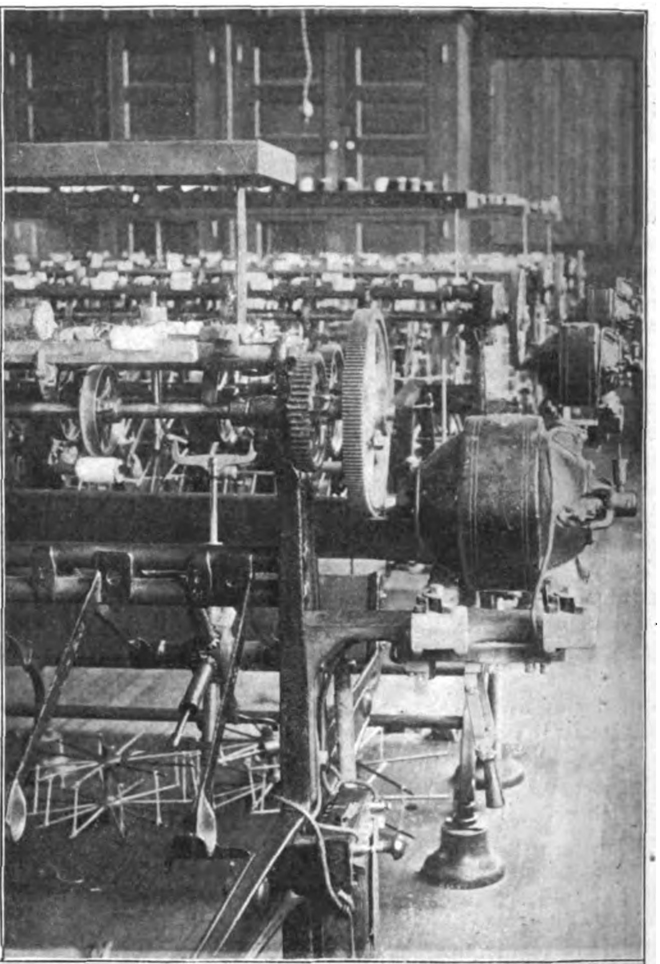


FIG. 6.—MOTOR-DRIVEN SILK WINDERS.

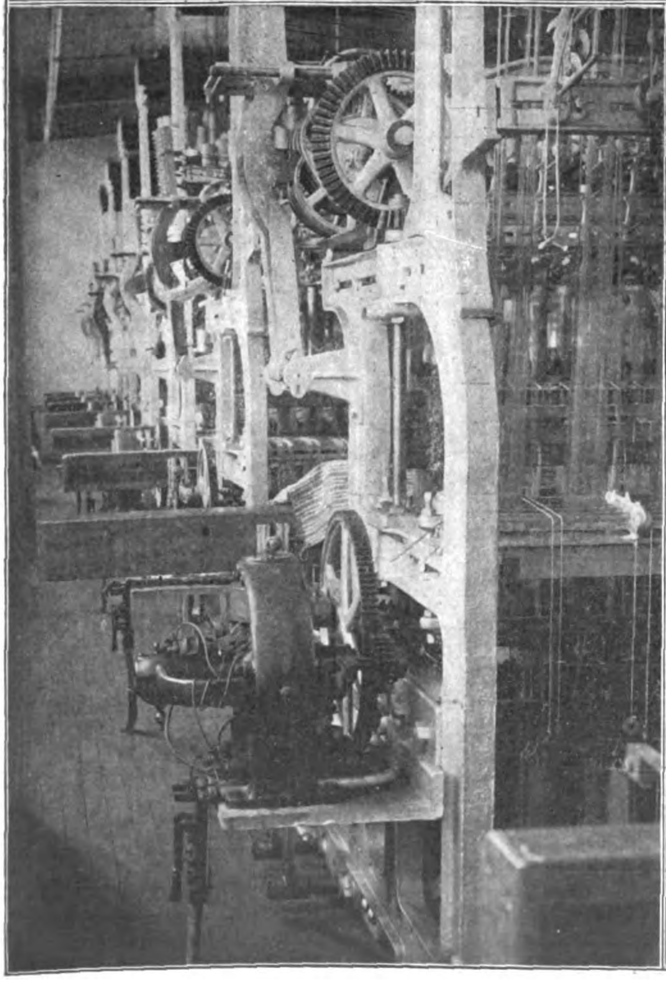


FIG. 7.—MOTOR-DRIVEN SILK LOOMS.

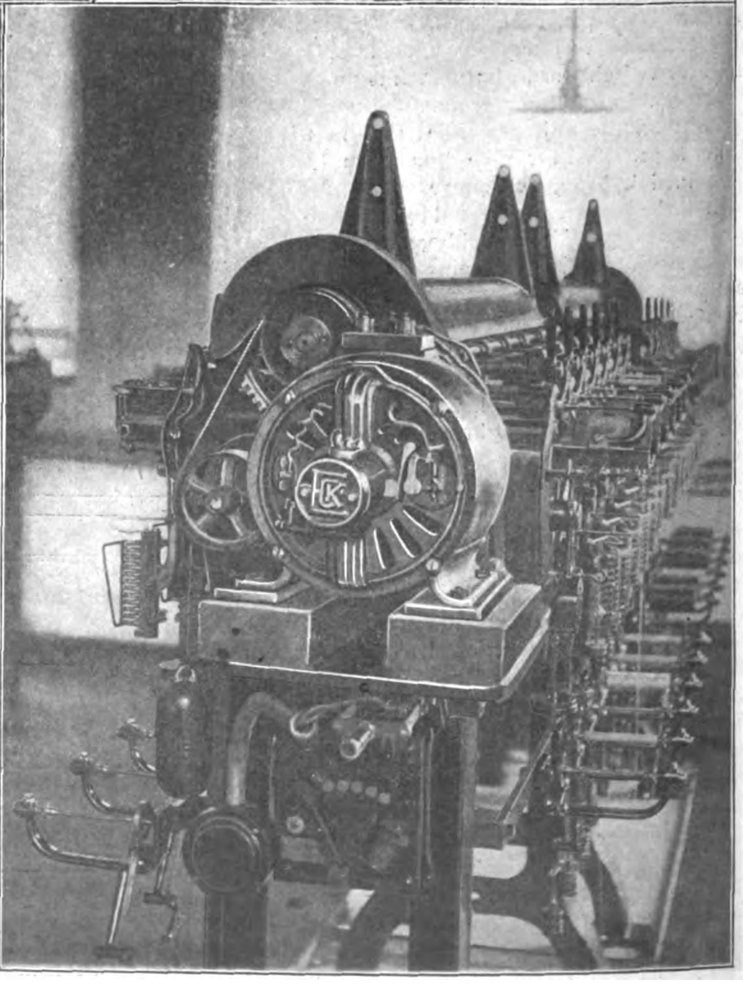


FIG. 8.—MOTOR-DRIVEN BOBBIN WINDERS.

feeder panels, a light showing when the circuit switch is thrown in.

Two sets of bus-bars are provided so that when the plant is in full operation one set may be used for power and one set for lighting service. In such a case the output of one generator is used exclusively for power purposes and the output of another for lighting. During the day, when the lighting load is comparatively small, both sets of bus-bars are connected by a switch and the power and lighting circuits supplied by one generator. The rating of the 200-kw. Crocker-Wheeler generators is merely nominal, since they are operated for a while every day at an output of 300 kilowatts before another generator is started. As intimated, three circuits are run to three distributing points situated approximately at the center of the load in the three buildings, where distributing boards are installed for controlling the various circuits radiating therefrom.

Current is carried to the switchboard from the generators by cables supported upon insulating brackets beneath the engine room floor. There are three leads running from each dynamo—a positive, negative and equalizer—the cross-section of each of which is 1,500,000 circular mils. A shunt field wire is also run from each generator to the board.

In all cases general illumination over a large area is furnished by enclosed-arc lamps. Incandescent lamps are largely used for the illumination of apparatus requiring a portable light, and the majority of individual machines are lighted in this manner. The normal lighting load is 200 kilowatts.

The motor equipment comprises over 100 motors of various sizes, ranging from ⅙ horse-power to 22 horse-power. Many manufacturers are at present represented in the motor installation. Figs. 5 to 8 illustrate some of the motor-driven units in the plant. The engravings show a whizzer, silk winders, silk looms and bobbin winders.

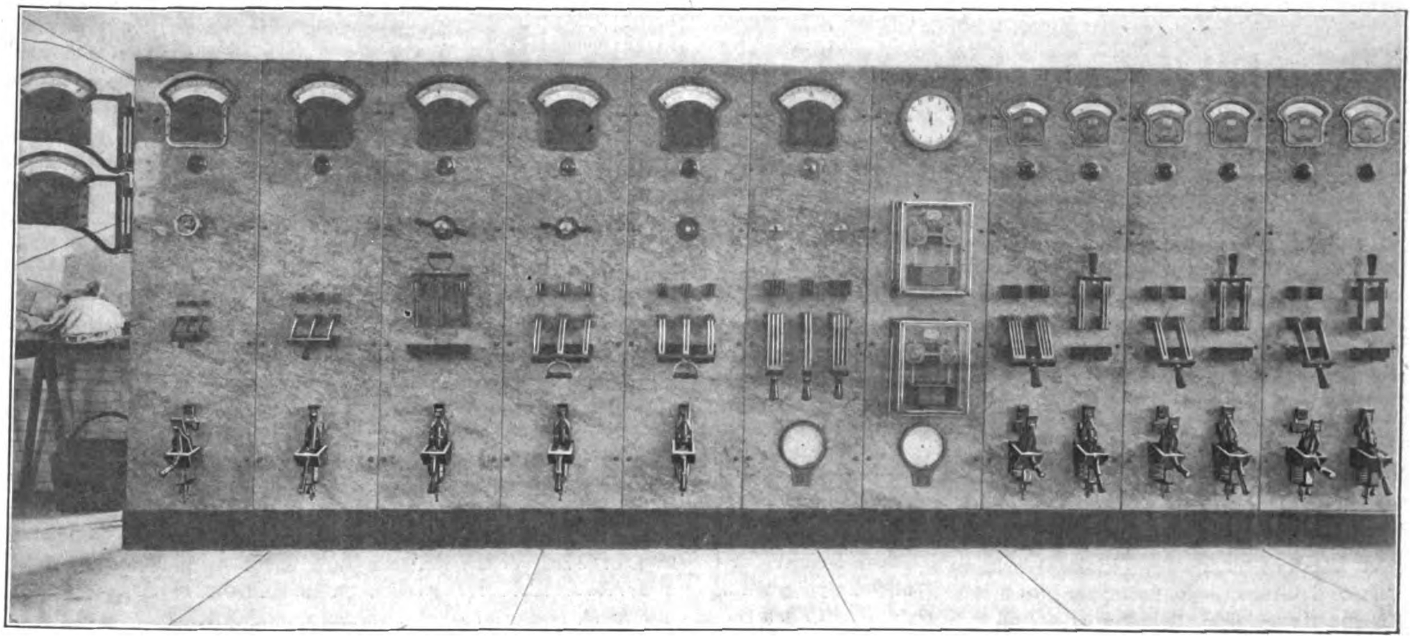


FIG. 9.—VIEW OF SWITCHBOARD; STETSON PLANT.

TELEPHONE ENGINEERING.

BY FRANZ J. DOMMERQUE.

POLES.

Poles vary in material, size and shape. Wooden poles are the standard, but iron poles have been used to a considerable extent and are still used in countries where wood is scarce; in the United States, however, there is under current practice hardly any cause for employing anything but wooden poles. The kind of wood used depends to a great extent upon the location of the telephone plant. In the north and west, cedar is mostly used, which grows in Michigan, Wisconsin and Idaho. In the Central, Eastern and some of the Southern States, chestnut is favored, which grows in Central and Southern Pennsylvania and New York State. Sometimes cypress poles are chosen in the South. Canada uses Canadian cedar, while on the Pacific coast we find poles of Oregon and Washington cedar and California redwood.

An all important factor in the life of the wood is its humidity. The percentage of humidity or sap, which is the same, differs not only with the kind of wood but also with the time of year. It is highest in December, January and February, and lowest in March and April. In the other months it is variable. Green wood, when cut and dried in the air, loses considerable of its humidity, but some always remains and can be expelled only by the application of heat. After a year's air drying, 20 to 25 per cent of humidity still remains and a prolonged exposure to air will not reduce this percentage much. At the present time it is the rule to be contented with air-dried poles. In a later article on the preservation of wood it will be shown how the remaining humidity may be removed after the air has done its duty.

The sap in the wood consists of water and organic substances, as well as minerals. Several of the organic substances easily decompose under certain conditions, principally when warm humidity and air are present, and the result is so-called "rot." We distinguish between "dry-rot" and "wet-rot." Dry-rot is attributed to the presence of a fungus in the wood which destroys its tensile and cohesive power and reduces it in course of time to a fine powder. Wet-rot is the most dangerous enemy of poles. The poles decay by a slow process of oxidation, mostly near the surface of the ground. Here the wood is submitted to frequent accumulations of dampness caused by rainfalls. The alternate wetting and drying, assisted by rapid changes in temperature, will decay the poles slowly but surely. Means for preventing this decay will be discussed in a future article.

All poles before being shipped should be air-dried, or, as it is commonly termed, "seasoned." A pole to be thoroughly seasoned requires two years of exposure under conditions that will draw out all the sap that can be drawn out, but leave the pole free from cracks and checks and without signs of warping. Freshly-cut poles are far heavier than seasoned poles of corresponding size, owing to the amount of sap contained, and inexperienced buyers may be misled into paying freight charges on sap under the delusion that they are paying for strength.

Poles are cut in varying sizes. The usual length is from 20 to 70 ft. when intended for line, anchor or distributing poles; for guy-poles, stubs or anchor logs, short pieces are more frequently used. It is the common rule to designate the thickness of a pole by its diameter at the top, five inches being the smallest and only permissible for 20 and 25-ft. poles carrying a few wires. The ruling diameters at the top are six, seven and eight inches. Table I gives data relating to cedar poles, and Table II gives similar data for chestnut poles. These poles are round; hexagonal and square poles are hardly ever used in telephone plants, such shapes being weaker per unit of weight, though they present a neater appearance. Prices of poles are given as at the shipping place, *i. e.*, without freight charges, but it must be understood that these prices are intended only to give a general idea of the approximate values, the variation in prices from time to time being very great. New prices should be ascertained whenever poles are to be bought.

TABLE I. CEDAR POLES.

Length in feet.	Diameter at top.	Approximate Weight of Poles. Seasoned.	Approximate Weight. of poles. Green.	Approximate Cost per pole, on Jan. 1, 1902.	Number of Poles per Carload.
20	5 ins.	130 lbs.	180 lbs.	$0.80	150 to 200 single car.
25	5 ins.	200 lbs.	260 lbs.	.75	125 to 150 single car.
25	6 ins.	250 lbs.	325 lbs.	1.30	100 to 125 single car.
30	6 ins.	350 lbs.	425 lbs.	1.70	80 to 100 single car.
30	7 ins.	450 lbs.	500 lbs.	3.00	70 to 80 single car.
35	6 ins.	500 lbs.	600 lbs.	3.25	60 to 75 single car.
35	7 ins.	600 lbs.	750 lbs.	4.00	55 to 70 single car.
40	7 ins.	850 lbs.	1000 lbs.	5.25	60 to 75 double car.
45	7 ins.	1000 lbs.	1150 lbs.	7.00	50 to 60 double car.
50	7 ins.	1250 lbs.	1400 lbs.	11.50	43 to 50 double car.
50	8 ins.	1450 lbs.	1625 lbs.	12.75	38 to 43 double car.
55	7 ins.	1550 lbs.	1775 lbs.	14.00	34 to 38 double car.
55	8 ins.	1800 lbs.	2060 lbs.	16.50	30 to 34 double car.
60	7 ins.	2000 lbs.	2300 lbs.	18.50	27 to 30 double car.
60	8 ins.	2500 lbs.	2800 lbs.	21.00	24 to 27 double car.
65	7 ins.	2700 lbs.	3000 lbs.	24.00	21 to 24 double car.
65	8 ins.	3200 lbs.	3600 lbs.	27.00	18 to 21 double car.

The designation of poles by their diameter at the top, although the usual custom, is not the proper thing from a technical standpoint. Measurements should be made with the tape line and circumferential measurements should be given. Poles are not often perfectly round and when diameters are given the diameter may be the longest one. In the specifications for poles given later the measurements of top and butt are given in circumferential measure. From this specification it will be seen that Michigan cedar poles taper considerably more than chestnut poles. It may be added that Western cedar poles (Idaho, Washington and Oregon) do not taper much, but are nearly as large at the top as they are at the bottom. Specifications for such poles should call for 25 ins. in circumference at the top, where Michigan cedar need be 22 ins. only. Such poles present a fine appearance, being shaped like a lead pencil, while chestnut poles, for instance, are seldom neat in appearance, being knotty and hardly ever straight.

TABLE II. CHESTNUT POLES.

Length in feet.	Diameter at top.	Approximate Weight of pole	Approximate Cost per pole.	Approximate number of poles to a carload.
20	5 ins.	250 lbs.	$0.60	100 per single car.
25	5 ins.	300 lbs.	.70	80 per single car.
25	6 ins.	425 lbs.	.80	75 per single car.
30	6 ins.	500 lbs.	1.25	66 per single car.
30	7 ins.	700 lbs.		54 per single car.
35	6 ins.	775 lbs.		80 per double car.
35	7 ins.	925 lbs.		74 per double car.
40	7 ins.	1230 lbs.		60 per double car.
45	7 ins.	1700 lbs.		40 per double car.
50	7 ins.	2225 lbs.		24 per double car.
55	7 ins.	2772 lbs.		17 per double car.

Chestnut poles, however, last better than cedar, as chestnut is generally sounder all the way through. But from the tables it will be seen that chestnut poles are much heavier than cedar, size for size, and therefore cost more for freight, hauling and labor. The relation is about as follows: Chestnut poles cause about 50 per cent. higher freight charges for equal distances, double the hauling charges and one-third more expense in erecting than cedar poles, while the first cost of chestnut poles is less and the life about 25 per cent longer. To the cost of poles at the shipping place the freight has to be added; the charges are best ascertained from the freight agent. Frequently the pole sellers quote prices delivered, but these quotations have their drawbacks. For estimating purposes the following data may prove a help; east of the Rocky Mountains the charge for a single car per 100 miles is somewhere near $10, and for a double car per hundred miles about $15. West of the Rocky Mountains the charges are higher.

It was mentioned previously that in small wire-plants each single pole is entered into the list, and it is therefore an easy matter to sum up the required number of poles as per the table given in that article. In large cities, however, it is about right to figure on 44 poles per mile and order poles accordingly; even if the number of poles as ordered in this manner does not come out right, there will be no loss on that account, as any large telephone company will possess a large poleyard where poles are stored and prepared for setting.

In ordering poles it will be found more satisfactory to clearly specify all the requirements that the dealer must meet before the shipment will be accepted, than to assume that certain conditions will be met because of some verbal understanding. Again, it is often more economical to purchase poles on board cars at the dealer's poleyard than to insist on prices delivered. In the former case the shipper will send a heavier pole than in the latter, and while the buyer will have relatively heavier freight charges to pay, this increased shipping cost is more than offset by the increased serviceableness of the heavier poles. Where the shipper agrees to deliver the poles on board cars at the place where the poles are to be used, it is customary for the shipper to select light weight poles in order that the freight charges per pole, which he must pay, may be as low as possible, and also that a maximum number of poles may be loaded on each car. The following may serve as a sample order of poles:

GENTLEMEN:—

Under the conditions hereinafter specified, please deliver the following enumerated selected cedar (or chestnut, or whatever the kind may be) telephone poles on board cars at your poleyard at or near.................station on the..................railroad.

(Then follows the table, giving number, size and quoted price of poles.)

The diameter at top of poles must not be less than specified, though a slightly larger diameter will be accepted.

These poles shall be of best quality of live second growth cedar (or whatever is required) without signs of dry or wet-rot; the heart to be of woody fibre, compact, dense and hard, free from sap, and without heart-cracks; they should have been cut preferably in midsummer when the growth of the year is ended, or in midwinter when the sap has apparently ceased to flow. There shall be as reasonable a taper as is possible in cedar (or whatever the material may be) poles from bottom to top, with no bend or twist that will give the pole a greater deflection from the true axis than five per cent. Each pole shall have butt and top squared before loading, be peeled clean of bark, and free from splinters and suncracks, with no appearance of being wind-shaken or wind-checked. All knots shall be closely trimmed; poles having excessive knots will not be accepted.

These poles must be properly loaded and firmly bound on the cars so as to travel to their destination without shifting or reloading. All charges made by railroad companies for reloading or rearrangement of poles while in transit, or for a transfer to other routes on account of the length and arrangement of the poles on the cars not permitting the cars to pass through all tunnels or to round all curves on the route, and all charges for repairs made to cars for break-downs due to improper loading, will be deducted from the amount of your invoice for the poles.

No payment for the poles will be made until a written report accepting the poles has been made by an inspector of this company. We prefer that our inspector should inspect, accept and stamp each pole before shipment is made from your yards; we agreeing to send him there on forty-eight hours' notice; but where this is impracticable we agree to inspect and mail to you our report on the poles within five days after the arrival of the poles at destination. Should we reject any of the poles you ship, they will be held subject to your orders. If you so desire we will then report on the desirability of cutting the rejected poles down to a size acceptable to us, or of accepting same as stubs or guy-poles.

Yours truly,

.... Telephone Company.

SYNCHRONOUS COMMUTATING MACHINES.

DISTRIBUTION OF CURRENT IN ARMATURE WINDINGS AND RELATIVE CAPACITIES COMPARED TO DIRECT-CURRENT GENERATOR AS UNITY. FRACTIONAL POWER FACTOR.

BY A. S. M'ALLISTER.

As a result of the variation in strength of the alternating current at the instant when each separate armature coil of a rotary converter or a double-current generator passes under a commutating brush, at which time the direct current within the coil is reversed, the maximum value of current to which a coil is subjected varies with the individual coils according to the location of each within the group constituting the windings of one phase—the windings between two adjacent collector-ring taps in a bipolar armature. The two end-coils, that is, the coils which connect the alternating-current leads to the adjacent groups on either side, carry greater values of current than the contiguous coils within the group, but these two coils do not have equal current values when the power factor of the alternating current is less than unity.

A knowledge of the relative increase in instantaneous value of maximum current is important and a study of its effect and location as to coils is instructive as indicating the existence of local heating within the armature windings. The value of this maximum current which flows within a single coil depends upon the number of phases and the power f ıctor of the current.

TABLE IV.

Type of Machine.	Rotary Converter.		Double-Current Generator.	
Number of Phases.	100% Power Factor	90.63% Power Factor.	100% Power Factor.	90.63% Power Factor.
2	3.00	3.21	1.50	1.60
3	2.33	2.70	1.27	1.35
4	2.00	2.47	1.21	1.28
6	1.67	2.21	1.17	1.24
Infinite	1.00	1.60	1.14	1.20

Table IV gives the relative values of this maximum current for different machines compared to a direct-current generator, at the same load, as unity.

Although the alternating current follows a sine wave, the current in individual coils does not follow a sine curve of time-value, and compared to its effective heating value, the maximum value is much greater than that obtained with a true sine curve. The maximum current flows for only a small fraction of the total time and is confined to a relatively small portion of the armature, so that the excess heating effect cannot at once be judged from Table IV, but must be determined by calculations similar to those recorded in columns 11 and 12 of Table III, which appeared in the preceding article and which is given again here for convenience.

Table III.— FOUR-PHASE SYNCHRONOUS COMMUTATING MACHINES. ANGLE OF CURRENT LAG = 0°. POWER FACTOR UNITY.

ROTARY CONVERTER.												DOUBLE CURRENT GENERATOR.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Time from maximum current.	Cosine of time angle.	Instantaneous value of alternating current.	Current in section a.	Current in section b.	Coils in section a.	Coils in section b.	Relative loss in section a.	Relative loss in section b.	Total relative loss.	Relative loss in coil No. 1.	Relative loss in coil No. 9.	Current in section a.	Current in section b.	Relative loss in section a.	Relative loss in section b.	Total relative loss.	Relative loss in coil No. 9.	Relative loss in coil No. 1.
θ	cosθ	Icosθ	I_a	I_b	R_a	R_b	$I_a{}^2R_a$	$I_b{}^2R_b$	I^2R	$I_1{}^2R_1$	$I_9{}^2R_9$	I_a	I_b	$I_a{}^2R_a$	$I_b{}^2B_b$	I^2R	$I_9{}^2R_9$	$I_1{}^2R_1$
0	1.0000	7.07	2.07	...	18	0	77	0	77	4.38	4.38	12.07	...	2620	0	2620	146.0	146.0
5	.9962	7.05	2.05	...	18	0	76	0	76	4.21	4.21	12.05	...	2615	0	2615	145.5	145.5
10	.9848	6.96	1.96	...	18	0	69	0	69	3.84	3.84	11.96	...	2570	0	2570	143.0	143.0
15	.9659	6.83	1.83	...	18	0	61	0	61	3.34	3.34	11.83	...	2521	0	2521	140.0	140.0
20	.9397	6.64	1.64	...	18	0	48	0	48	2.68	2.68	11.64	...	2440	0	2440	135.5	135.5
25	.9063	6.41	1.41	...	18	0	36	0	36	1.99	1.99	11.41	...	2350	0	2350	130.5	130.5
30	.8660	6.12	1.12	...	18	0	23	0	23	1.26	1.26	11.12	...	2235	0	2235	124.0	124.0
35	.8192	5.79	.79	...	18	0	11	0	11	.62	.62	10.79	...	2100	0	2100	116.2	116.2
40	.7660	5.42	.42	...	18	0	3	0	3	.18	.18	10.42	...	1962	0	1962	108.7	108.7
45	.7071	5.00	.00	10.00	18	0	0	0	0	50.00	.00	10.00	.00	1800	0	1800	100.0	50.0
50	.6428	4.55	.45	9.55	17	1	3	91	94	91.20	.20	9.55	.45	1552	0	1552	91.2	.2
55	.5736	4.06	.94	9.06	16	2	14	164	178	82.10	.88	9.06	.94	1315	2	1317	82.1	.9
60	.5000	3.54	1.46	8.54	15	3	32	218	250	73.05	2.13	8.54	1.46	1092	6	1098	73.0	2.1
65	.4226	2.99	2.01	7.99	14	4	57	255	312	63.80	4.04	7.99	2.01	892	16	908	63.8	4.0
70	.3420	2.42	2.58	7.42	13	5	87	275	362	55.00	6.66	7.42	2.58	715	33	748	55.0	6.7
75	.2588	1.83	3.17	6.83	12	6	121	280	401	46.60	10.05	6.83	3.17	560	60	620	46.6	10.0
80	.1736	1.23	3.77	6.23	11	7	157	272	428	38.75	14.21	6.23	3.77	427	100	527	38.8	14.2
85	.0872	.62	4.38	5.62	10	8	192	252	444	31.60	19.20	5.62	4.38	316	154	470	31.6	19.2
90	.0000	.00	5.00	5.00	9	9	225	225	450	25.00	25.00	5.00	5.00	225	225	450	25.0	25.0
95	.0872	.62	5.62	4.38	8	10	252	192	444	19.20	19.20	4.38	5.62	154	316	470	31.6	31.6
100	.1736	1.23	6.23	3.77	7	11	272	157	428	14.21	14.21	3.77	6.23	100	427	527	38.8	38.8
105	.2588	1.83	6.83	3.17	6	12	280	121	401	10.05	10.05	3.17	6.83	60	560	620	46.6	46.6
110	.3420	2.42	7.42	2.58	5	13	275	87	362	6.66	6.66	2.58	7.42	33	715	748	55.0	55.0
115	.4226	2.99	7.99	2.01	4	14	255	57	312	4.04	4.04	2.01	7.99	16	892	908	63.8	63.8
120	.5000	3.54	8.54	1.46	3	15	218	32	250	2.13	2.13	1.46	8.54	6	1092	1098	73.0	73.0
125	.5736	4.06	9.06	.94	2	16	164	14	178	.88	.88	.94	9.06	2	1315	1317	82.1	82.1
130	.6428	4.55	9.55	.45	1	17	91	3	94	.20	.20	.45	9.55	0	1552	1552	91.2	91.2
135	.7071	5.00	10.00	.00	0	18	0	0	0	.00	.00	.00	10.00	0	1800	1800	100.0	100.0
140	.7660	5.42	...	.42	0	18	0	3	3	.18	.18	...	10.42	0	1962	1962	108.7	108.7
145	.8192	5.79	...	.79	0	18	0	11	11	.62	.62	...	10.79	0	2100	2100	116.2	116.2
150	.8660	6.12	...	1.12	0	18	0	23	23	1.26	1.26	...	11.13	0	2235	2235	124.0	124.0
155	.9063	6.41	...	1.41	0	18	0	36	36	1.99	1.99	...	11.41	0	2350	2350	130.5	130.5
160	.9397	6.64	...	1.64	0	18	0	48	48	2.68	2.68	...	11.64	0	2440	2440	135.5	135.5
165	.9659	6.83	...	1.83	0	18	0	61	61	3.34	3.34	...	11.83	0	2521	2521	140.0	140.0
170	.9848	6.96	...	1.96	0	18	0	69	69	3.84	3.84	...	11.96	0	2570	2570	143.0	143.0
175	.9962	7.05	...	2.05	0	18	0	76	76	4.21	4.21	...	12.05	0	2615	2615	145.5	145.5
180	1.0000	7.07	...	2.07	0	18	0	77	77	4.38	4.38	...	12.07	0	2620	2620	146.0	146.0
185	.9962	7.05	...	2.05	0	18	0	76	76	4.21	4.21	...	12.05	0	2615	2615	145.5	145.5
Mean.—Omitting Duplicates.									170	18.19	5.01					1631.6	95.0	81.66

Table V above, indicates the relative values of the maximum and the minimum losses in individual coils on the armature of synchronous commutating machines of various phases at power factors of 100% and of 90.63%, compared to the mean armature loss per coil under the same condition of service. The results here recorded, therefore, indicate the relative lack of uni-

TABLE V.

Maximum and Minimum Losses in Individual Coils.

Type of Machine.	Rotary Converter.				Double-Current Generator.			
Number of Phases.	100% Power Factor Max.	Min.	90.63% Power Factor. Max.	Min.	100% Power Factor. Max.	Min.	90.63% Power Factor. Max.	Min.
2	2.270	.331	2.462	.334	1.201	.650	1.462	.443
3	2.161	.405	2.748	.343	1.084	.828	1.132	.647
4	1.926	.531	2.600	.391	1.048	.903	1.094	.753
6	1.590	.725	2.217	.461	1.018	.955	1.065	.852
Infinite	1,000	1,000	1,000	1.000	1.000	1.000	1.000	1.000

formity of distribution of heat loss in the armature windings.

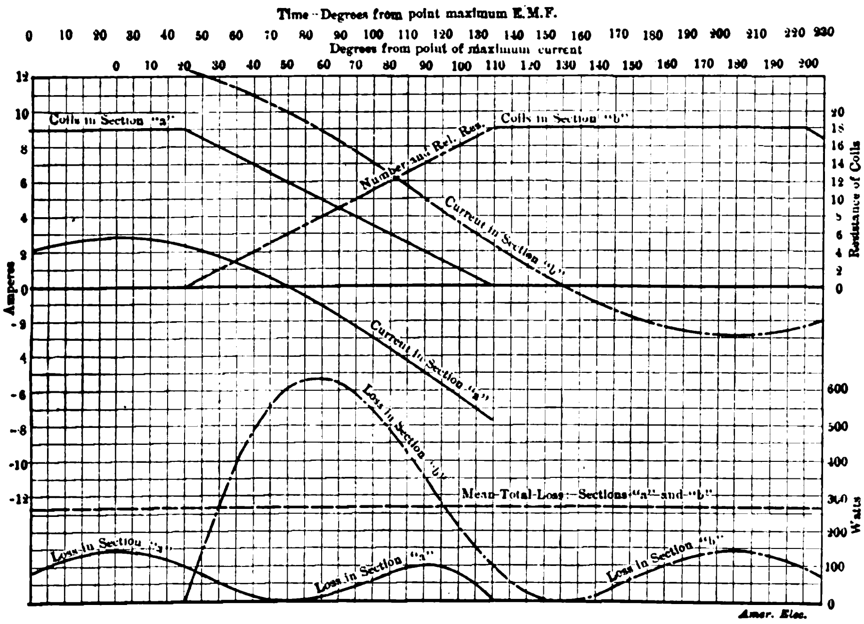


FIG. 6.—DISTRIBUTION OF LOSS IN ARMATURE OF FOUR-PHASE SYNCHRON OUS CONVERTER.

When a rotary converter is operated at a power factor less than unity two effects are observed: There is required a proportionately larger current to produce a given power, and the maximum current does not flow in a given group of coils when the coils are generating their maximum e. m. f. Though the relative loss for a given machine does not vary regularly with decrease in power factor, it is sufficient for present purposes to determine the effect of operating the machines at a single fairly low value of power factor.

Assume that the current lags 25° behind the rotary e. m. f. The power factor is, therefore, cos. 25°=.9063 and the maximum value of current instead of being 7.071, as before for the four-phase rotary converter is now 7.071 ÷ .9063 = 7.81 amperes, and this maximum occurs when the armature has moved forward 25° from the position giving maximum e. m. f., or, what is the same thing, the armature must now rotate forward only 20° before the group of coils begins to pass under the brush instead of 45°, as when the current and e. m. f. are in phase.

TABLE VI.—FOUR-PHASE SYNCHRONOUS COMMUTATING MACHINES. ANGLE OF CURRENT LAG=25°. Power Factor .9063.

ROTARY CONVERTER.												DOUBLE CURRENT GENERATOR.						
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Time from maximum current.	Cosine of time angle.	Instantaneous value of alternating current.	Current in section a.	Current in section b.	Coils in section a.	Coils in section b.	Relative loss in section a.	Relative loss in section b.	Total relative loss.	Relative loss in coil No. 1.	Relative loss in coil No. 14.	Current in section a.	Current in section b.	Relative loss in section a.	Relative loss in section b.	Relative loss—total.	Relative loss in coil No. 14.	Relative loss in coil No. 1.
θ	cosθ	Icosθ	I_a	I_b	R_a	R_b	$I_a^2 R_a$	$I_b^2 K_b$	I^2R_1	$I_1^2 R_1$	$I^2_{14} R_{14}$	I_a	I_b	$I_a^2 R_a$	$I_b^2 R_b$	$I^2 R$	$I^2_{14} R_{14}$	$I_1^2 R$
0	1.0000	7.81	2.81	...	18	0	142	0	142	7.90	7.90	12.81	...	2960	0	2960	164.1	164.1
5	.9962	7.78	2.78	...	18	0	139	0	139	7.62	7.62	12.78	...	2940	0	2940	163.2	163.2
10	.9848	7.68	2.76	...	18	0	129	0	129	7.19	7.19	12.68	...	2890	0	2890	160.8	160.8
15	.9659	7.55	2.55	...	18	0	117	0	117	6.51	6.51	12.55	...	2840	0	2840	156.8	156.8
20	.9397	7.33	2.33	12.33	18	0	98	0	98	78.71	5.42	12.33	2.33	2740	0	2740	152.0	78.7
25	.9063	7.07	2.07	12.07	17	1	73	146	219	145.80	4.28	12.07	2.07	2480	4	2484	145.8	4.3
30	.8660	6.76	1.76	11.76	16	2	49	277	326	138.20	3.01	11.76	1.76	2220	6	2226	138.2	3.0
35	.8192	6.41	1.41	11.41	15	3	30	391	421	130.20	1.99	11.41	1.41	1960	6	1966	130.2	2.0
40	.7660	5.98	.98	10.98	14	4	13	482	495	120.20	.96	10.98	.98	1690	4	1694	120.2	1.0
45	.7071	5.52	.52	10.52	13	5	4	554	558	111.00	.27	10.52	.52	1440	1	1441	111.0	.3
50	.6428	5.02	.02	10.02	12	6	0	602	602	100.40	.00	10.02	.02	1205	0	1205	100.4	.0
55	.5736	4.48	.52	9.48	11	7	3	628	631	89.80	.27	9.48	.52	990	2	992	89.8	.3
60	.5000	3.91	1.09	8.91	10	8	12	635	647	79.30	1.19	8.91	1.09	792	9	801	79.3	1.2
65	.4226	3.30	1.70	8.30	9	9	26	620	646	68.90	2.89	8.30	1.70	621	26	647	68.9	2.9
70	.3420	2.67	2.33	7.67	8	10	43	588	631	58.80	5.42	7.67	2.33	471	54	525	58.8	5.4
75	.2588	2.02	2.98	7.02	7	11	62	541	603	49.30	8.89	7.02	2.98	345	97	442	49.3	8.9
80	.1736	1.36	3.64	6.36	6	12	80	485	565	40.50	13.25	6.36	3.64	243	159	402	40.5	13.2
85	.0872	.68	4.32	5.68	5	13	94	419	513	32.20	18.70	5.68	4.32	161	243	404	32.2	18.7
90	.0000	.00	5.00	5.00	4	14	100	350	450	25.00	25.00	5.00	5.00	100	350	450	25.0	25.0
95	.0872	.68	5.68	4.32	3	15	97	281	378	18.70	18.70	4.32	5.68	56	484	540	32.2	32.2
100	.1736	1.36	6.36	3.64	2	16	81	212	293	13.25	13.25	3.64	6.36	26	648	674	40.5	40.5
105	.2588	2.02	7.02	2.98	1	17	49	151	200	8.89	8.89	2.98	7.02	9	840	849	49.3	49.3
110	.3420	2.67	7.67	2.33	0	18	0	98	98	5.42	5.42	2.33	7.67	0	1040	1040	58.8	58.8
115	.4226	3.30	...	1.70	0	18	0	51	51	2.89	2.89	...	8.30	0	1240	1240	68.9	68.9
120	.5000	3.91	...	1.09	0	18	0	21	21	1.19	1.19	...	8.91	0	1430	1430	79.3	79.3
125	.5736	4.48	...	.52	0	18	0	5	5	.27	.27	...	9.48	0	1620	1620	89.8	89.8
130	.6428	5.02	...	.02	0	18	0	0	0	.00	.00	...	10.02	0	1805	1805	100.4	100.4
135	.7071	5.52	...	.52	0	18	0	5	5	.27	.27	...	10.52	0	1992	1992	111.0	111.0
140	.7660	5.98	...	.98	0	18	0	17	17	.96	.96	...	10.98	0	2170	2170	120.2	120.2
145	.8192	6.41	...	1.41	0	18	0	36	36	1.99	1.99	...	11.41	0	2350	2350	130.2	130.2
150	.8660	6.76	...	1.76	0	18	0	56	56	3.01	3.01	...	11.76	0	2490	2490	138.2	138.2
155	.9063	7.07	...	2.07	0	18	0	77	77	4.28	4.28	...	12.07	0	2620	2620	145.8	145.8
160	.9397	7.33	...	2.33	0	18	0	98	98	5.42	5.42	...	12.33	0	2740	2740	152.0	152.0
165	.9659	7.55	...	2.55	0	18	0	117	117	6.51	6.51	...	12.55	0	2840	2840	156.8	156.8
170	.9848	7.68	...	2.68	0	18	0	129	129	7.19	7.19	...	12.68	0	2890	2890	160.8	160.8
175	.9962	7.78	...	2.78	0	18	0	139	139	7.62	7.62	...	12.78	0	2940	2940	163.2	163.2
180	1.0000	7.81	...	2.81	0	18	0	142	142	7.90	7.90	...	12.81	0	2960	2960	164.1	164.1
185	.9962	7.78	...	2.78	0	18	0	139	139	7.62	7.62	...	12.78	0	2940	2940	163.2	163.2
					Mean.—Omitting Duplicates.				266	38.48	5.795					1730	105.1	72.4

Bearing these facts in mind and making proper substitution in Table III, there is obtained by a method similar to the one used previously a mean relative copper heat loss in the group of coils of 266 (Table VI) which, compared to the loss of 450 for the direct-current generator, indicates a relative output of $\sqrt{\frac{450}{266}} = 1.300$ as compared with the direct-current generator.

The method of determining the output from the double-current generator is quite similar to that used above. In this case, however, the direction of flow of the alternating current at the time of maximum value is the same as that of the direct current, so that the sum, and not the difference, must be taken in determining the resultant current. Columns 13 and 14 of Table III will show the manner in which the instantaneous value of resultant current varies. The relative loss of 1730 is for equal direct and alternating-current outputs so that the relative total output for the same loss as in a direct-current generator will be $2 \times \sqrt{\frac{450}{1730}} = 1.094$.

Table VI records the calculation for determining the effect of a lag of 25° in the alternating current for the double-current generator, and, as the method is quite the same as used for the rotary converter, it need not be further discussed. The relative capacities of alternating-current machines compared with a direct-current generator as unity are given in Table VII.

TABLE VII.
Relative Capacities of Alternating-Current Machines; Direct-Current Capacity = 1.

Type of Machine.	Rotary Converter		Double-Current Gen.		Alt.-Cur. Generator.	
Number of Phases.	100% Power Factor.	90.63% Power Factor.	100% Power Factor.	90.63% Power Factor	100% Power Factor.	90.63% Power Factor.
2	.848	.731	.931	.890	.7071	.6418
3	1.338	1.103	1.023	.992	.9186	.8325
4	1.627	1.300	1.050	1.020	1.0000	.9063
6	1.937	1.482	1.066	1.038	1.0610	.9612
Infinite	2.291	1.648	1.082	1.052	1.1105	1.0066

The results recorded in Table VII are plotted in the form of curves in Fig. 7, so as to show to the eye the effect of varying the number of phases of a given machine. It will be seen at a glance that increasing the number of phases in each case increases the capacity of the machine, but that the relative increase for alternating-current and double-current generators is small compared to the increase for rotary converters. A change from three to six phases with an alternating-current generator results in an increased capacity of 15.5%, while an equivalent change with a rotary converter produces from 35% to 45% greater output, depending upon the power factor of operation. These latter figures may be increased or decreased if the current wave departs materially from the assumed sine curve of time-value, though the figures as given represent results obtained in practice.

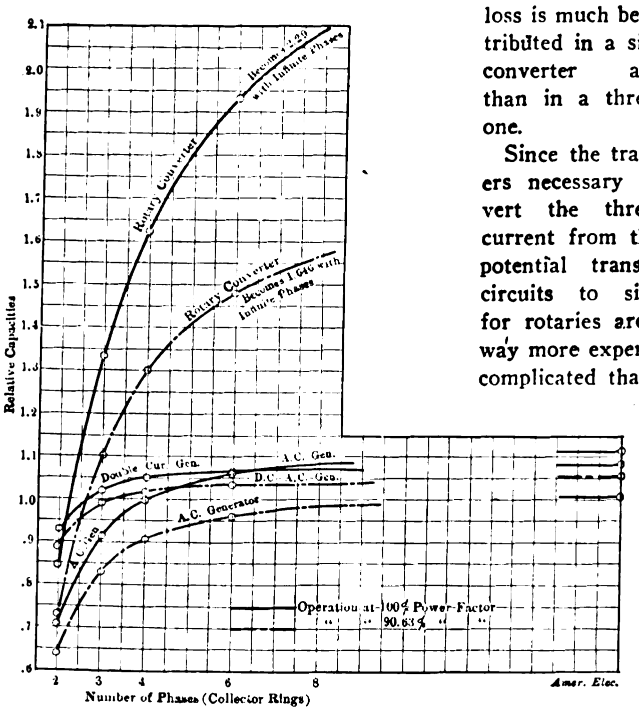


FIG. 7.—CAPACITIES OF ALTERNATING-CURRENT MACHINES COMPARED TO DIRECT-CURRENT GENERATOR.

The increase in capacity of a rotary converter resulting from a change from the so-called single-phase to three-phase is from 51% to 57%. Therefore, changing a given rotary from three-phase to six results in from 70% to 80% as great increase in capacity as changing from single to three-phase. Reference to Table V will show that with a three-phase rotary converter one section of the armature windings is subjected to from 5.3 to 8 times as great current heating effect as certain others, while, with a six-phase machine, the corresponding results are 2.2 and 4.8. This means that the heat loss is much better distributed in a six-phase converter armature than in a three-phase one.

Since the transformers necessary to convert the three-phase current from the high potential transmission circuits to six-phase for rotaries are in no way more expensive or complicated than those for three-phase rotaries, economy in cost of equipment and efficiency of operation dictates the use of six-phase machines, and where the size of the rotaries operated justified the additional connecting circuits between the transformers and the machines, six-phase rotary converters should be used.

◆◆◆

Electrical Development of the Susquehanna River.—Several large electrical power plants are under way at various points along the Susquehanna River, in the vicinity of York, Pa. At Conowingo Falls a 35,000-h.p. power house is in process of construction, from which power will be transmitted to Wilmington, Del., and Chester, Pa. A 40,000-h.p. plant is to be built at Peachbottom, the power from which will be transmitted to Baltimore and intermediate points; and surveys are in progress at York Furnace for a plant of similar capacity.

ELECTRIC ELEVATOR CONTROL SYSTEMS

BY H. D. JAMES.

The object of the present article is to describe the fundamental features of some of the representative types of electric elevator control, and this being the case, the writer has not attempted to give the complete connections of the various systems except in the case of one of the best known and most generally used. There are two general methods of controlling electric elevators; one in which the operator by means of a lever or wheel closes the main switch near the motor in one direction or the other, according to the direction in which the car is to be driven, and a graduated resistance in the armature circuit is cut out automatically by either gravity or by electromagnetic mechanism which is put into circuit by the main switch at the same time that the motor is connected to the line. In the other general method of control the work of operating the reversing switch is done electromagnetically and the magnet or magnets which accomplish this are controlled by a small switch in the car, which has to deal with currents of only small strength comparatively. The latter system is commonly referred to as the "electric" control, while the former is commonly called "mechanical" control, although the acceleration of the machine is usually accomplished by electromagnetic mechanism.

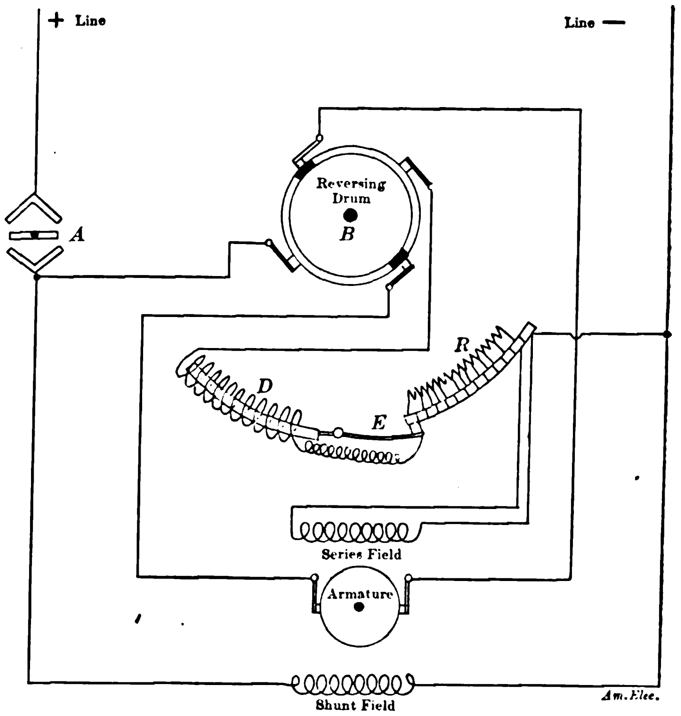


FIG. 1.—SIMPLE SYSTEM OF MECHANICAL CONTROL.

Fig. 1 herewith illustrates one of the simpler systems. In this diagram *A* represents conventionally the main switch, the horizontal lever being pivoted in the center and susceptible of being thrown either way to close the circuit; *B* is the reversing drum, which is thrown one way or the other, according to the direction in which the car is to go, by a mechanical system operated from the car and to which is coupled the main switch *A*. The brake, which is not shown, is lifted by means of a cam or other connection from the shaft of the reversing drum and main switch.

When the machine is thrown into circuit, the armature is connected in series with the solenoid *D*, the rheostat *R*, and the series field winding; the shunt field winding is connected directly to the mains. When the reversing drum, *B*, is in the "off" position, as shown in the diagram, a mechanical connection between it and the core of the solenoid, *D*, holds the latter up in the position indicated, but when the drum is rotated in either direction, so as to throw the motor in circuit, the solenoid core is released and falls by gravity, cutting out by means of the finger *E* the sections of the rheostat *R* and accelerating the motor. The coil of the solenoid serves to retard the fall of the core, the retardation being roughly proportional to the amount of current passing through the armature; the greater the current the slower will the plunger descend. When the drum is thrown to the "off" position again, the mechanical connection between it and the solenoid core raises the latter back to its starting position. This arrangement has proved satisfactory for machines up to 15 horse-power, and has been used with considerable success on machines of larger size.

Fig. 2 illustrates a more widely used form of mechanical control. In this arrangement the reversing switch *A A'* is also the main circuit closing and opening switch; the brake shoes are withdrawn from the brake wheel by means of a magnet, the coil of which is indicated in the diagram, and the graduated resistance, *R*, in series with the armature is cut out by means of a solenoid *D* connected permanently in shunt to the armature. When the wheel or lever in the car throws the reversing switch one way or the other, closing the circuit to the motor, the brake-magnet coil is connected straight across the main circuit and the shunt field winding is similarly connected, except that the direction of flow through the shunt field is always the same no matter which way the reversing switch is thrown, while the current through the brake magnet is reversed, like that through the armature. There is no object in causing this result; it is merely incidental to the connections, which are made in the manner that is most convenient. When the circuit is closed, all of the resistance *R* is in series with the armature, as shown in the diagram. As soon as the armature attains sufficient velocity to cause an appreciable difference of potential at the brushes, the solenoid *D* is energized and begins to cut out the resistance, accelerating the armature and thereby increasing the difference of potential at the brushes. The motion of the plunger is thus accelerated until all of the resistance is cut out. This arrangement is very satisfactory for both large and small machines.

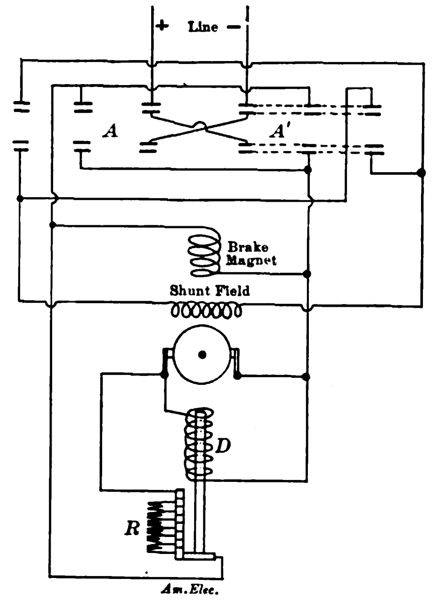


FIG. 2.—MECHANICAL CONTROL.

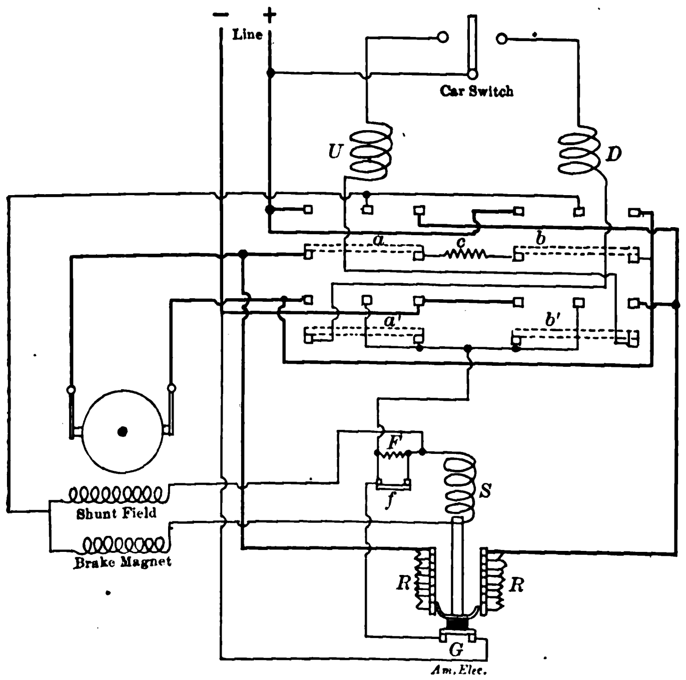


FIG. 3.—SIMPLE ELECTRICAL CONTROL SYSTEM.

One of the simpler electrical control systems is illustrated in Fig. 3. In this arrangement there are two main line switches, which also control the direction in which the motor runs, and which are actuated by the magnets *U* and *D*, the magnet *U* closing the circuit so as to cause the elevator to be pulled up, and the magnet *D* closing the circuit in the direction for descent. The switches are represented as being composed of plates *a*, *a'* and *b*, *b'*, the plates *a* and *a'* being lifted by the magnet *U* and the other two plates being lifted by the magnet *D*. In the position of rest the plates occupy the positions shown. If the car switch is thrown to the left, the magnet *U* is energized, lifting the plates *a* and *a'* against their respective rows of upper contacts. Tracing the circuits will show that this puts the armature in circuit in series with a graduated resistance, *R R*, connects the shunt field directly across the line, and connects the brake magnet winding and the solenoid coil, *S*, across the line in series with each other.

The solenoid *S* then raises its plunger, cutting out the resistance and accelerating the armature. When the plunger reaches its highest position, it throws the bridge *f* away from its contacts, inserting the resistance *F* in series with the shunt field winding and also with the brake-magnet and solenoid windings; this serves to give the motor armature its maximum speed and to reduce the current flowing through the brake magnet and solenoid to the value just sufficient to hold the brake and the solenoid plunger positively in their uppermost positions.

When the plates *a* and *a'* were raised by the magnet *U*, the contacts which they had previously bridged were separated electrically, thus opening the circuit through the coil *D* and preventing the operator from causing that coil to raise the plates *b b'* so long as the plates *a* and *a'* are in the upper position. When the car switch is thrown back to the center, opening the circuit through the magnet *U*, the switch plates are dropped, of course, to the position shown in the diagram, in which position the return circuit of the magnet *D* is restored, and the motor armature is close-circuited through a resistance *c*, serving to brake the machine and assist the retarding action of the mechanical brake.

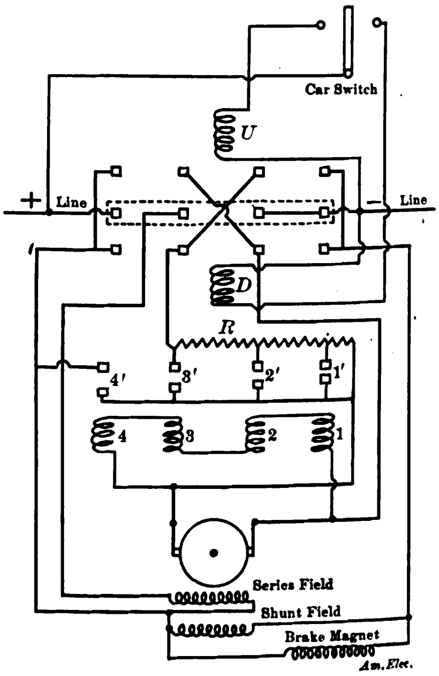


FIG. 4.—MAGNET CONTROL SYSTEM.

The contacts and bridge *G* at the bottom of the solenoid plunger constitute part of a return circuit for the switch magnets *U* and *D* when all the switch plates are in the lowest position. Consequently, if the solenoid plunger should fail to return to its bottom position and leave some of the resistance *R* cut out, the operator will be unable to close either of the magnetic switches, because their return circuit will be open at *G*. After the switch plates *a* and *a'* or *b* and *b'* have been raised to their upper contacts, they close their own return circuits, rendering the solenoid powerless to open the switch-magnet circuit by means of the break at *G* so long as the switch magnet is active.

Fig. 4 illustrates one form of what is known as the "magnet" control system, in which the car switch is indicated conventionally by a strap and two buttons, as in the case of Fig. 3. In this system, a single reversing switch is used, which is thrown either one way or the other by one of the two magnet coils *U* and *D*, according to the direction in which the elevator is to be moved. In the diagram, the switch bar is indicated by dotted lines, and its motion upward is supposed to bring the four square contact pieces shown enclosed by the dotted lines into contact with the square plates above them. A downward motion similarly puts the four middle plates into contact with the four immediately below them. In either case the armature is connected to the line through the series field winding and the resistance coil, *R*, while the shunt field winding and brake magnet coil, which are connected permanently in parallel, are thrown directly across the line.

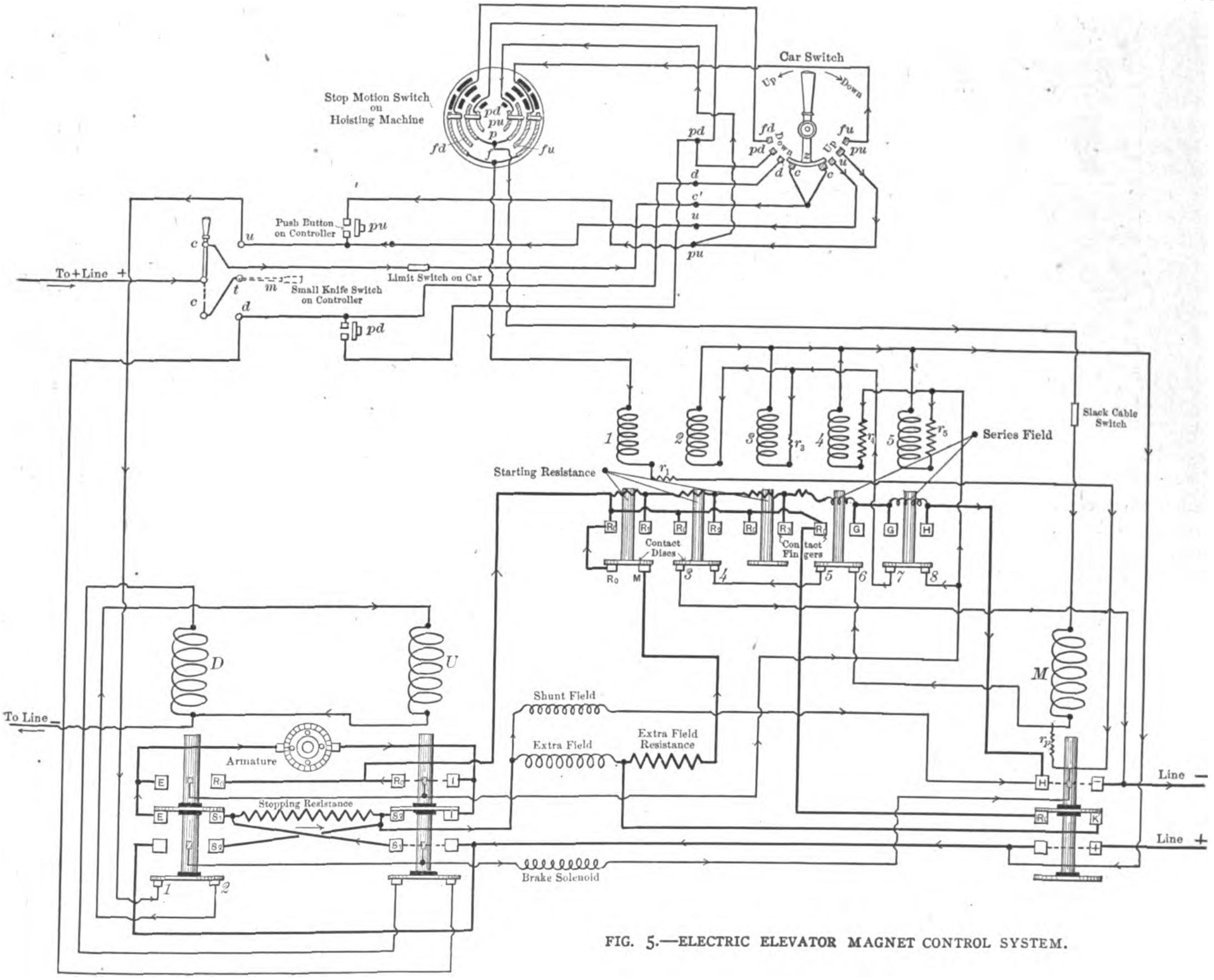

Car Switch
Up
Down
Stop Motion Switch on Hoisting Machine
pd
pu
p
fd
fu
f
pd
fd
pd
Down
d
c
z
c
Up
u
fu
pu
d
c'
u
pu
Push Button on Controller
pu
c
u
To + Line +
c
t
m
Small Knife Switch on Controller
Limit Switch on Car
d
pd
1
2
3
4
5
r_3
r_4
r_5
r_1
Series Field
Slack Cable Switch
Starting Resistance
R_0
R_1
R_2
R_3
G
G
H
Contact Discs
Contact Fingers
R_0
M
3
4
5
6
7
8
D
U
M
To Line
Shunt Field
Extra Field
Extra Field Resistance
Armature
E
E
R_0
R_0
I
I
Stopping Resistance
S_1
S_2
S_3
S_1
1
2
Brake Solenoid
r_p
H
−
R_0
K
+
Line −
Line +

FIG. 5.—ELECTRIC ELEVATOR MAGNET CONTROL SYSTEM.

The coils *1*, *2*, *3* and *4* indicate electromagnets which when properly energized close respectively the contacts *1'*, *2'*, *3'* and *4'* immediately above them.

When the armature is thrown on the line the rush of current through it causes a difference of potential at the brushes, and as the four magnet coils are connected permanently in series and across the brushes they are slightly energized. The adjustments are such that as the armature speeds up and the difference in potential at the brushes increases, the magnet *1* closes first, followed in succession by the magnets *2*, *3* and *4*. The first three magnets cut out the resistance *R* by sections, while the fourth one short-circuits the series field, leaving the machine running as a plain shunt motor. This system is excellently adapted to high-duty machines, but it is open to the objection that the elevator attendant can cause trouble by throwing the car switch over from one side to the other, reversing the motor, before the magnets *1*, *2*, *3* and *4* have had time to release and restore the resistance to the armature circuit.

An elaboration of this system is shown in Fig. 5, in which a separate electromagnetic main switch *M* is used in addition to the directional switches *U* and *D*. In this arrangement there are five accelerating switches, three of which cut out sectional resistance in the armature circuit and the other two cut out sections of a series field winding. The operation of this system is somewhat more complicated than that of those just described.

Suppose, for example, the car-switch handle to be thrown to the left until its shoe bridges the first two contacts *c* and *u*. As the contact *c* is permanently connected to the positive line, current will be admitted to the contact *u*, whence it passes by an easily traced path to the reversing magnet *U*, energizing that magnet, which makes the proper armature connections to run the car upward. Further motion of the lever bridges the second contact *pu*, which admits current to the solenoid. *M*, and this solenoid closes the main circuit to the machine and connects the brake magnet to the circuit. The accelerating magnets *2*, *3*, *4* and *5* are connected across the brushes, exactly as in the system previously described, and when the machine is thrown in circuit by the solenoid *M* these magnets operate one after the other to cut out the starting resistance and series field winding.

Further motion of the car switch lever causes its shoe to bridge the last contact *fu*, which energizes the coil of the accelerating magnet *1*, and causes that magnet to open the circuit of the extra field winding on the machine, weakening the motor field and causing it to take its maximum speed. In stopping, the handle is brought back to the central position, of course, which reverses the operations just described. When the cores of the solenoids *U* and *D* are in the "off" position, as shown in the diagram, the "stopping resistance" shown between the two plungers is connected across the brushes of the motor, so that the generation of current in the armature may serve as a brake, as in the case of the system shown in Fig. 3. It is not necessary, however, in stopping to throw the switch handle entirely back to the center and demagnetize whichever of the switches *D* or *U* may be in use; if it is thrown back until it touches only the contacts *c* and *u*, this will de-energize the main switch *M* and stop the elevator. The lowest contacts of the directional switches *D* and *U* enable each switch to open the circuit of the other one when it itself has been energized, and thus prevent the elevator attendant from energizing both of the switches at the same time by throwing the car switch handle quickly from one side to the other. Fig. 6 illustrates the controller, and Fig. 7 shows the interior of the car switch.

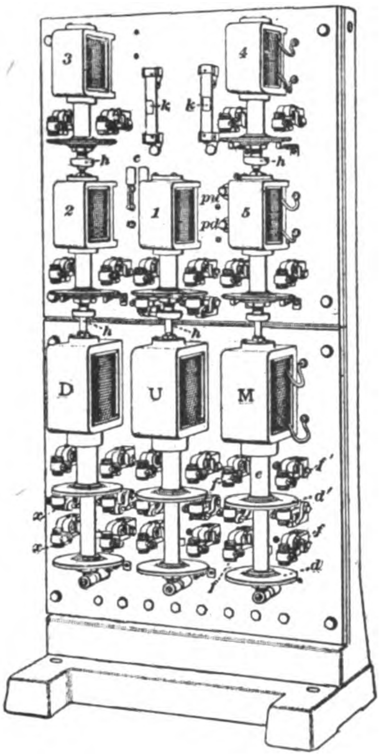


FIG. 6.—CONTROLLER.

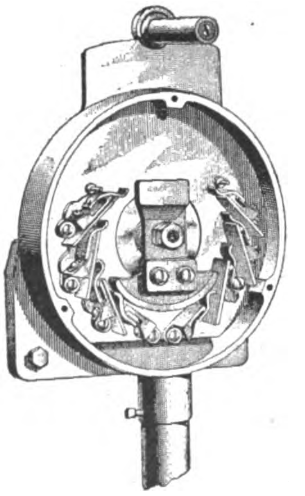


FIG. 7.—INTERIOR OF CAR SWITCH.

ECONOMIZERS.

BY H. F. SCHMIDT.

There is hardly a plant of any considerable size installed at the present day which is not fitted with economizers or air heaters to extract as much as possible of the heat of the flue gases that would otherwise be wasted up the chimney without doing any useful work. Despite this fact and the great saving that economizers have shown where they have been installed, there are still many power plant owners as well as many engineers who do not realize the saving which results by the use of some device to save this heat, and it is with a hope of winning over some of these that the following exposition of some of the facts regarding the use of economizers is given.

From the results of a large number of boiler tests in which the temperature of the flue gases was taken, it has been found that this temperature varies from 400 degs. to 800 degs. Fahr., though the average temperature is not far from 575 degs. or 600 degs. with good boilers and modern pressures. It is also known that the temperature of the escaping flue gases must necessarily be considerably higher than that of the steam and water in the boiler. Pressures of from 200 lbs. to almost 300 lbs. per square inch are now widely used, which pressures correspond to temperatures of from 381 degs. to 414 degs. Fahr., respectively, which at once limit the extent to which the flue gases can be cooled by the boiler itself.

The question now arises, How much heat is wasted in the flue gases? This can easily be calculated by assuming the amount of air admitted below the grates and the temperature at which it is discharged into the chimney. To do this let us assume that with the natural draft 300 cubic feet of air are required per pound of coal burned; also that the temperature of the atmosphere is 62 degs. Fahr., and that the temperature of the escaping flue gases is 600 degs. Fahr. The specific heat of carbonic acid gas at constant pressure is 0.2163, that of nitrogen 0.2438, and that of air 0.2374. Also when a pound of carbon is burned it forms 3.06 lbs. of carbonic acid (CO_2), and for convenience it may, without any practical error, be considered that one pound of coal contains 85 per cent. of carbon, and also that the entire pound of coal passes up the stack. Hence the heat contained in the flue gases will be: $H = (11.05 \times .2374 + 9.08 \times .2438 + 3.12 \times .2163)\ (600-62) = 3021.4$ B. T. U. If the heat value of one pound of coal is 12,080 B. T. U., under the above conditions 25 per cent. of the total heat in the coal would be lost up the stack. This could be reduced by using a smaller air supply, but unless the draft and stoking were very favorable, the coal would not be properly burned.

In the accompanying table (I) are given the heat losses by flue gases at various temperatures and different volumes of air supplied under the grates; the data and the calculation of each figure in the table were as in the example just worked out, except that the average value of Cumberland coal (12,230 B. T. U. per pound) was used. Although these values are not absolutely correct for any coal, they are very probably correct within the limits of the errors of observation. The losses are given for temperatures of from 200 degs. to 700 degs., and for volumes varying from 150 to 350 cubic feet of air per pound of coal, the lowest that can possibly be obtained by the use of mechanical draft.

TABLE I.—SHOWING THE B. T. U. CONTAINED IN THE GASES OF COMBUSTION LEAVING THE BOILER AT VARIOUS TEMPERATURES, AND DIFFERENT VOLUMES OF AIR SUPPLIED PER POUND OF COMBUSTIBLE.

Flue Gas Temp.	Volume of air supplied in cubic feet.								
	350	325	300	275	250	225	200	175	150
700°	4158.5	3870.7	3583.	3294.	3006.	2718.	2429.6	2141.2	1853.4
675°	3995.6	3719.	3443.	3165.	2888.	2611.	2334.	2058.	1781.
650°	3832.6	3567.	3302.	3036.	2770.	2505.	2239.	1974.	1708.
625°	3669.6	3415.6	3162.	2907.	2653.	2398.	2144.	1890.	1636.
600°	3506.7	3264.	3021.40	2778.	2535.	2292.	2049.	1806.	1563.
575°	3343.8	3112.4	2880.	2649.	2417.	2185.	1954.	1722.	1490.
550°	3180.8	2960.6	2740.	2520.	2299.	2079.	1858.	1638.	1418.
525°	3017.9	2809.	2600.	2391.	2181.	1972.	1763.	1554.	1345.
500°	2854.9	2657.	2459.	2261.	2064.	1866.	1668.	1470.	1272.
475°	2691.95	2506.	2319.	2132.	1946.	1759.	1573.	1386.	1200.
450°	2529.	2354.	2178.	2003.	1828.	1653.	1477.	1302.	1127.
425°	2366.	2203.	2038.	1874.	1710.	1546.	1382.	1218.	1054.
400°	2203.	2052.	1898.	1745.	1592.	1440.	1287.	1134.	982.
375°	2040.2	1899.	1757.	1616.	1475.	1333.	1192.	1051.	909.
350°	1877.2	1748.	1617.	1487.	1357.	1227.	1097.	967.	836.
325°	1714.3	1596.	1477.	1358.	1239.	1120.	1001.	883.	765.
300°	1551.3	1444.	1336.	1229.	1121.	1013.	906.	799.	692.
275°	1388.4	1292.	1196.21	1100.	1004.	907.	811.	715.	619.
250°	1225.4	1141.	1055.8	971.	886.	801.	716.	631.	546.
225°	1062.5	989.	915.4	842.	768.	694.	621.	547.	474.
200°	899.48	837.24	775.02	712.	650.	588.22	525.48	463.19	400.9

In considering this table it should be observed that as the air supply is increased the furnace temperature falls, thus lowering the efficiency of the boiler in absorbing heat from it, and resulting in just the reverse of what one would think would be the case, that is, that the temperature of the flue gases would be higher than when the furnace temperature was higher. Hence it is evident that it is more important to extract the heat from the gases when the air supply is large (as with ordinary chimney draft) as both the volume and temperature of the waste gases are higher.

It is next necessary to find the amount of heat that could be absorbed from the flue gases economically in order to determine what saving could be effected by such extraction of the heat. Experiment has shown that the gases may be economically cooled down to 250 degs. or 275 degs. Fahr., hence one may assume that a final temperature of 275 degs. will be maintained. Then the saving in B. T. U. per pound of coal will be:

$$H' = (11.05 \times .2374 + 9.08 \times .2438 + 3.12 \times .2163)\ (600 - 275) = 1825.2$$

B. T. U.

TABLE II.—SHOWING THE SAVING IN B. T. U, PER POUND OF COMBUSTIBLE PRODUCED BY REDUCING THE TEMPERATURE OF THE GASES OF COMBUSTION DOWN TO 275°, 325° AND 375° RESPECTIVELY.

	350 Cu. Ft.			325 Cu. Ft.			300 Cu. Ft.			275 Cu. Ft.			250			225			200			175			150		
F°	275	325	375	275	325	375	275	325	375	275	325	375	275	325	375	275	325	375	275	325	1238	275	325	375	275	325	375
700	2770	2444	2119	2579	2275	1972	2387	2106	1825	2194	1936	1678	2002	1766	1531	1811	1598	1385	1619	1428	1143	1426	1343	1091	1234	1089	944
675	2607	2281	1956	2427	2125	1820	2247	1966	1684	2065	1807	1549	1882	1649	1413	1704	1491	1278	1523	1333	1047	1343	1175	1007	1162	1017	871
650	2444	2119	1793	2275	1972	1669	2106	1825	1544	1936	1678	1420	1766	1531	1205	1598	1385	1172	1428	1238	952	1259	1091	923	1089	944	799
625	2281	1955	1630	2125	1820	1517	1966	1684	1404	1807	1549	1291	1649	1413	1179	1491	1278	1065	1333	1143	857	1175	1007	839	1017	871	726
600	2118	1793	1467	1972	1669	1365	1825.2	1544	1263	1678	1420	1161	1531	1205	1060	1385	1172	959	1238	1047	762	1091	923	755	944	799	653
575	1956	1630	1304	1820	1517	1214	1684	1404	1123	1549	1291	1032	1413	1179	942	1278	1065	852	1143	952	666	1007	839	671	871	726	581
550	1793	1467	1141	1669	1365	1062	1544	1263	982	1420	1161	903	1205	1060	824	1172	959	746	1047	857	571	923	755	587	799	653	508
525	1630	1294	978	1517	1214	911	1404	1123	842	1291	1032	774	1179	942	706	1065	852	639	952	762	476	839	671	503	726	581	435
500	1467	1141	815	1365	1062	706	1263	982	702	1161	903	645	1060	824	588	959	746	533	857	666	381	755	587	419	653	508	363
475	1304	978	652	1214	911	607	1123	842	561	1032	774	516	942	706	471	852	639	426	762	571	286	671	503	336	581	435	290
450	1141	815	489	1062	760	456	982	702	420	903	645	387	824	588	353	746	533	320	666	476	190	587	419	252	508	363	217
425	978	652	326	911	607	304	842	561	280	774	516	258	706	471	235	639	426	213	571	381	95	503	336	168	435	290	146
400	815	489	163	760	456	152	702	420	140	645	387	129	588	353	117	533	320	106	476	286	....	419	252	84	363	217	73
375	652	326	....	607	304	....	..561	280	....	516	258	....	471	235	....	426	213	....	381	190	....	336	168	....	290	146	....
350	489	163	....	456	152	....	420	140	....	387	129	....	353	117	....	320	106	....	286	95	....	252	84	....	217	73	....
325	326	....	....	304	....	....	280	....	....	258	....	....	235	....	....	213	....	....	190	....	....	168	....	....	146	....	....
300	163	....	....	152	....	....	140	....	....	129	....	....	117	....	....	106	....	....	95	....	375	84	....	....	73	....	....

In this calculation the same data were taken as before, except the final temperature. If now one assumes an evaporation of 11.25 lbs. of water from and at 212 degs. per pound of coal, and also assumes feed water supply at 60 degs., then the 1825.2 B. T. U. would have raised the temperature of the feed water to 222 degs. F. This, it is evident, would represent a saving of 14.86 per cent. of the total weight of the coal used, and also allow certain of the scale-forming salts to be precipitated in the economizer, thus reducing the amount of scale formed in the boiler and enhancing its economy as well as prolonging its life.

As the cost of erection, transportation and fuel varies in different localities and the coal consumption per horse-power per year also varies between very wide limits, according to the class of engine and the work being done, it is impossible to predict accurately what saving would be effected by the use of economizers. However, it is easily evident that there could hardly be any ordinary conditions under which the cost of fuel and cost of economizers and erection would be such that a saving of 14.86 per cent. of the fuel bill would not give a good return on the capital invested in the economizers, to say nothing of reducing the wear and tear on the boilers, which suffer less deterioration from expansion and contraction as well as corrosion.

If by the use of economizers the temperature of the flue gases is lowered to a point below 300 degs. the draft will be very much impaired, and unless the chimney is of very unusual height it might reduce the capacity of the plant and limit the quality of coal which could be used, as the finer and poorer grades of coal require considerable draft for proper combustion. Hence it is necessary to provide mechanical means to produce the draft or assist the chimney, or else the temperature of the flue gases must not be so much reduced. In most cases the former course is more desirable, as was shown by the present writer in an article on mechanical draught in the February, 1902, number of the AMERICAN ELECTRICIAN. Even if the temperature of the flue gases is left high enough to produce sufficient draught, the saving by the use of economizers will still show them to be a good investment, except in a few special cases.

In a non-condensing plant it is an advantage to first heat the water by the exhaust steam, thus raising its temperature to 125 degs. or 150 degs., after which it passes into the economizer where its temperature can be raised to that of the water in the boiler without difficulty, and a large supply of hot water for washing purposes can be provided, as is desired in many manufacturing plants. Of course, if the feed-water heater is used, the economizer may be very much smaller to obtain a given ultimate result.

The results of numerous tests on economizer installations show that the saving of coal by their use varies from 10 per cent. to 20 per cent., while the average and general result lies between 13 per cent. and 15 per cent.

An economizer should, if properly constructed, conform to the following general specifications. It must be constructed of cast iron to withstand the action of the sulphur in the flue gases. All the tubes should be forced into the headers by hydraulic pressure, making a metal to metal contact and avoiding the use of "made" joints, which are a constant source of trouble. The economizer must be so constructed that it may be cleaned out and repaired easily, and must be fitted with an automatic scraping device which constantly cleans the soot off the tubes; even a very thin covering of soot will almost entirely destroy the usefulness of the equipment. It must be tested to a pressure of from 350 to 450 lbs. per square inch. The path of the water should be in the opposite direction to that of the hot gases, so that a maximum difference of temperature is maintained between the hot gases and the water within the tubes. The heating surface should be ample and the water must remain in the tubes from 20 to 40 minutes. The transverse area of the air spaces between the tubes must be large so that the gases may move through the economizer slowly in order to give up their heat as completely as possible with the smallest possible heating surface.

If conforming to these points and carefully built, it should last at least as long as the boilers and will probably last longer, by which time it would more than have paid for itself and a new economizer could be installed in its place.

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Carbon Electrodes — In a paper read before the American Electrochemical Socity recently, Mr. Fitzgerald pointed out that in certain electrolytic processes the use of amorphous carbon electrodes is unsatisfactory because of their rapid disintegration in the electrolyte. This may be overcome to a certain extent by special methods of manufacture or by using amorphous carbons, such as retort carbon, which show greater resistances to disintegration. Similar remarks apply to the use of carbon electrodes for the electric furnace in metallurgical work. Of all forms of carbon, graphite shows the greatest resistance to oxidizing and disintegrating actions. When, therefore, it is possible to use carbon at all graphite gives the best result. It is obvious, however, that an electrode made like the ordinary graphite brush, such as is frequently used on dynamos and motors, would be of little use, since the graphite particles are held together by a binding material of amorphous carbon and consequently disintegration would be nearly if not quite as rapid as in the use of amorphous carbon electrodes. To obtain the best possible results the electrode should contain no amorphous carbon, and it is therefore important to have some method of testing electrodes to determine whether they are composed entirely of graphite. Reference was made to M. Berthelot's method of separating the different forms of carbon by submitting them to the oxidizing action of a mixture of nitric acid and potassium chlorate and Staudenmaier's method was favored in testing an electrode to determine whether it contains a certain amount of graphite.

Twenty-First Convention of the American Street Railway Association.

The twenty-first annual convention of the American Street Railway Association, held in Detroit October 8, 9 and 10, was, as usual, remarkably well attended, and when President Vreeland called the meeting to order on Wednesday morning, October 8, several hundred delegates and visitors were present to participate in the opening exercises. An admirable address of welcome was delivered by Mayor Maybury, and Mr. Vreeland then delivered his presidential address, which was one of the best, if not actually the best, that has ever been presented to this association.

In his opening remarks, President Vreeland referred to the appropriateness of holding the twenty-first annual meeting of the American Street Railway Association in Detroit, for, while the city street railways of the country have not been idle during the last year, the greatest development in electric railway work since the last convention, and, in fact, for several years has been in the direction of interurban electric railways, and in this class of road Detroit railway enterprise has always been prominently identified, the city ranking with Cleveland, Indianapolis, Cincinnati and Dayton as the important centers in this country of the interurban railway industry.

The interurban railways, he said, have long since passed the stage when they could be considered simply as suburban extensions of city lines. They are doing a through business, which is constantly growing, and the later and more ambitious examples of roads of this class are built with a track construction inferior in no respect to the best practice of the steam railroad companies. They operate usually for the greatest part of their distance over private rights of way, and attain speeds which enable them to compete successfully with their steam-railroad rivals for nearly every class of traffic except long-distance passenger and freight business. This extension of the electric railway has introduced new problems of discussion, such as fares, transportation of freight, etc., into the operating department, as well as the exercise of the most advanced electrical engineering methods, not only in the transmission of the power at high voltage necessary to operate the cars, but in the car equipment as well. Up to the present, direct current has been used on the trolley wire or third rail, but if the experiments with single-phase motors, which it is announced are soon to be tried, prove successful, the possibility of the direct application of alternating current to railway work will remove some of the inconveniences which now exist in the present system.

Mr. Vreeland said he would not take up time discussing statistics, but it was interesting to note, in passing, that eleven years ago there were about 1,800 miles of electric railways in the country, while today there are between 24,000 miles and 25,000 miles, and that against an investment eleven years ago in street railways of about $75,000,000, the total capital invested to-day is in the neighborhood of $2,000,000,000. These figures, he said, show that the time has come when the association should no longer apologize for its existence, but should take a stand individually and as an association for the protection of its rights as a corporation.

Mr. Vreeland entered at length into the relations of electric railways with the public. The contract between the public and the street railroads is a contract of partnership, and the interest of the partners is identical. What the public wants is the best possible service, and only by giving the best possible service can a railway company obtain the largest possible returns on its investment. Despite this close association of interest, it is the experience that there is scarcely any limit to the impositions which the public will permit, and rather cheerfully permit, to be laid upon street railway corporations. Legislatures and boards of aldermen seem to regard street railways as fair game to be hit at as often and as viciously as anybody chooses, and the public newspapers, so far from taking into account the service rendered and furnishing protection against the schemes of demagogues, are rather inclined to regard injuries so inflicted with amused indifference, if not with positive favor.

J. C. HUTCHINS,
PRESIDENT AMERICAN STREET RAILWAY ASSOCIATION.

In every other form in which property manifests itself, except in shares of corporate stock, it has well defined rights and valuable privileges. Money lent to the government at a comfortable rate of interest is no more directly employed upon the public business than that which is represented by the stock of a street railway, and it is no answer to the claim that it ought to have fair treatment, that it ought not to be the object of special prejudice and attack, to say that the property is particularly valuable, for its value is strictly measured by the public service it renders. And yet the contracts between the public and the street railway companies are being continually infringed upon by the imposition of new taxes and new requirements, and it has come to be considered almost an impertinence for a corporation so injured to offer ever so mild a protest.

It is not remarkable, said Mr. Vreeland, that in this situation the law should discriminate against corporations. The failure to assert rights when they are threatened is always taken as a confession that they do not exist, and encroachment follows encroachment with ruthless certainty. Timid counsels have so far prevailed among the street railroad companies in the adjustment of their affairs with the public that in many states there is a gross discrimination in the taxing laws against such corporations.

An important part of the address was devoted to the consideration of the future of the association. It had served an honorable and useful purpose for twenty-one years, but the time, he said, may be at hand when the scope of its usefulness can be materially increased, and attention is directed to the broader field of electric railroading which this country will certainly see during the next decade. Referring to the immense mileage of interurban electric railways built during the last few years, especially in the Middle West, he said that broader problems are being forced upon the electric railway interests of the country, which naturally look to the association as the exponent of their interests. This is only natural, because while these lines do not operate upon the streets, the electrical equipment problems connected therewith, as well as many of the other questions which arise in connection with their operation, are the same as those which interest street railway managers proper. While it may appear inadvisable to change the name of the association is not merely a street rail- to accord with the broader field of electric railroading in which many of its members are engaged, it should be understood that the Association is not merely a street railway organization, but its scope covers the entire field of electric railway transportation. More than this, it may seem desirable to welcome the participation of all companies engaged in electric railway transportation, for the reason that there is no organization in the country which has accomplished so much, or at its annual conventions and exhibitions affords anywhere near the same opportunity for instruction to those interested in electric transportation in its different phases. Heretofore no manager or engineer of a trunk line company which is contemplating or has installed a system of electric traction could join this association except as a representative of some street railway company; but in view of the interest which is being taken in electric railway equipment by some of the large trunk line interests and the undeniable future which electric power will have for such transportation, especially for terminal and suburban work, the question will arise in the near future, if it has not already done so, whether the benefits which this association can confer are available for companies which are not now eligible to membership.

Various reports of committees were then presented, on behalf of the secretary and treasurer and the executive committee. It appeared that there are 191 companies in membership, of which 88 companies are situated in Massachusetts, New York Ohio, Illinois and Pennsylvania. The balance sheet showed cash in bank, October 1, 1901, $10,128; receipts during the year, $8,378; expenditures, $8,559, and cash in hand October 1, 1902, $9,948.

The first paper presented at the convention was one by Mr. C. D. Meneely, of the Brooklyn Heights Railway Company, on the subject of

Registration of Transfers.

A considerable portion of the paper consisted of a discussion of the chief arguments that have been advanced for and against the registration of transfers, the conclusion arrived at being that the advantages more than compensated for the disadvantages. An account was given of the system used on the Brooklyn Rapid Transit Railway, the operation of which is as follows:

Transfers are taken out of the hands of conductors and transfer agents are placed at points where cars from the same depot intersect and transfer, thereby preventing conductors from trading directly with each other and compelling the use of an intermediary. This is supplemented by the vigilant watchfulness of inspectors and secret service operators. The system of stationing uniformed register inspectors between all principal terminal points and the first transfer intersection practically protects the revenue between the outer transfer and terminal points, and enables the company to concentrate its secret service in the central portion of the system, to locate register shorts and detect transfer trading. Further, to limit the risk of trading to the day of issue, the company introduced and was the first to use, a daily dated transfer ticket, which has since been adopted by many of the principal systems in the country. Doubtless, a further check upon transfer trading is provided by the turning in of transfers by trips and the subsequent checking of line exchanges by the accounting department.

Mr. Meneely said that were it not for the lottery law and a certain demoralizing effect that distribution of property by chance has upon the community by inculcating the gambling spirit, it would be possible to offer such inducements to street railway patrons as would absolutely check the cash fares received and the transfers issued. Such a governing inducement would be to offer cash prizes of a large amount monthly, which would yet form in the aggregate only a small fraction of the amount which is now diverted from the company's revenue by conductors. In addition to carrying a pad of transfers, the conductors would be provided with a pad of numbered cash-fare receipts, each one of which receipts would bear on its face an injunction to hold until the end of the month, when the bearer might be entitled to any one of a number of prizes, determined impartially by a drawing; the prizes consisting of a capital sum, together with lesser sums graded down to a large number of small premiums, which would distribute the cash prizes as far as possible.

The operation of this plan would involve the issue of a transfer only for a cash fare. In practice it would work as follows: A passenger, boarding a car, would be asked by the conductor, upon payment of fare, if he wished a transfer. Upon receiving an affirmative reply, the conductor would issue a numbered transfer to the passenger from his pad, and upon turning in his pad would have to produce one cash fare for each transfer ticket detached from his pad. All passengers who desire transfers would be sure to get them, as they are needed for a ride on the transferring line, and conductors would, therefore, not be able to again issue detached transfers.

On the other hand, if a passenger, upon paying his fare, stated that he did not wish a transfer, it would become the conductor's duty to detach a cash fare receipt and hand it to the passenger. For every cash fare receipt so detached the conductor would also be held accountable for one cash fare. The inducement for a passenger to take a cash fare receipt would be even stronger than in the case of a transfer ticket, as it might mean a large sum of money in case the number of the ticket drew a prize, and when a passenger, ignorant of its possible value, refused to accept his fare receipt, others would eagerly seek its possession.

Assuming that both transfer tickets and cash fare receipts were taken by passengers for all fares paid, the stubs returned by the conductors would accurately indicate the number of fares collected and would ensure the turning into the treasury of all the revenue collected on the cars.

Several marked advantages would follow from the adoption of this plan, as for example, the reduction in the number of transfers used, since many persons, who would ordinarily take a transfer for a short ride after a long one, would prefer the chance offered by the cash fare receipt and decline the transfer, which carried with it no chance for a prize. Moreover, the number of short-distance riders would probably be increased to an extent that would realize a larger sum than the aggregate of the prizes offered; and, again, the trading of transfer tickets between conductors would be rendered absolutely impracticable, for each transfer detached from a conductor's pad would mean a corresponding cash fare to be turned into the company's treasury, and he would, therefore, be debarred from substituting transfers from other lines for cash fares.

While, according to the opinion of counsel, the operation of this plan would not violate the letter of the lottery law, inasmuch as no consideration is asked or received for the cash prizes distributed, yet the decisions under the federal lottery law, which absolutely prohibit the circulation of notices of drawings through the mails, in the opinion of counsel renders the operation of the plan inadvisable.

While, perhaps, the adoption of this plan might stimulate a speculative spirit in the community, it is unfortunate from the point of view of street railway companies that some similar scheme for the absolute protection of revenue could not be devised that would not contravene state or federal laws.

In the discussion, Mr. Root, of New York, said he was opposed to registration in such large cities as New York. The paper was also discussed by Messrs. W. E. Harrington, H. W. Sloan, E. G. Connette, John I. Beggs, the last of whom described the points of value in a registration system as applied to travel in Milwaukee. Mr. W. B. Tarkington said that at Council Bluffs they registered transfers, with register bells of different tones, and that the public took quite an interest in watching to see what was rung up. Col. Heft also believed that every ticket tendered as evidence of fare should be registered. The morning session then adjourned.

At the Tuesday afternoon session, Mr. Oren Root, of New York, presented a paper on

The Street Railway Mutual Benefit Association.

The author discussed at length mutual benefit and assessment assurance associations as applicable to street railway employees, and gave an account in detail of the Metropolitan Street Railway Association, of New York, which was organized in the spring of 1897. All employees of the Metropolitan Street Railway between the ages of twenty-one and forty-five years who have been in the service of the company for three months are eligible for membership upon the payment of $1 and dues of fifty cents per month. In return for these payments the association guarantees to its members:

1st. In case of sickness the payment of $1 a day for a period not exceeding ninety days in any one year.

2d. In case of death the payment of $300 to any beneficiary named by the insured.

3d. The free service of a physician who devotes his entire time to the members of the association.

4th. The use of reading rooms, which are supplied with weekly and monthly papers and magazines, technical journals and a library consisting of over 2,000 volumes.

5th. The use of ten pool tables, for which 1 cent per cue is charged.

6th. Free monthly lectures and entertainments during the winter months at the association rooms.

7th. Eligibility for pension under the pension regulations of the Metropolitan Street Railway Company.

The association started with thirty members, and from that time it has steadily grown until to-day it has a membership of over 4,500. The association is operated with absolutely no expense beyond the stipulated salary of a physician, as all of the officers to the association are officers of the company and their services to the association are given gratuitously. The association rooms are given rent free by the company; the library and pool tables were donations from individual stockholders and directors. It has been found that the amount of the tax, 50 cents per month, is a trifle more than is necessary to pay sick benefits and supply a life insurance of $300, but it is so small, in each individual case, as to make an exact adjustment both inconvenient and impossible, and hence there has grown up in this association a practice of investing the surplus in securities of the property on which the members are employed. There is thus the unique feature of every member contributing monthly, in an infinitesimal way it is true, to a proprietary interest in the property he helps to operate.

Mr. Root considers that the success of the Metropolitan Street Railway Association is primarily due not so much to its sound economic features as to the personal relationship established and maintained between the responsible head of the railway company and its employees. An intelligent, sympathetic relation has been fostered and encouraged between the manager and his men who early realized that they were under the discipline of a man who was in thorough accord with them as a class and whose life experiences had been along the very lines they themselves were traveling. The fusing influence of this relationship, which is as active to-day as at any time since the formation of the association, has welded the membership into a body the tremendous force of whose loyalty has been frequently tested in critical emergencies. The impetus thus given to this association is great enough to assure its permanence beyond the accidental loss of the influence of the individual who is responsible for its present energy.

In the application of social benefits, as in everything else of human devising, some vivid personal influence is necessary to success, and this success cannot be achieved by mere formal approbation or endorsement. Many good things are spoiled by being over-magnified and among American and Americanized working men there is a resentment of official patronage. The quickening influence of the idea that you and your men are engaged on the same job, but in different capacities, when once fixed, is surprising. It would be well, too, not to lose sight of the fact that the benefits arising from helping your men to take care of themselves are not all one-sided.

The benefits arising from associations may be divided into two classes: First, those derived by the employees, and second, those derived by the employer. There is nothing which appeals more strongly to the large majority of people, certainly to those who have worked for a living, than those things which yield direct or indirect financial return. No one can fail to see the great benefit which the distribution of from $20,000 to $25,000 a year means to the men who are working for wages, and without reserves to draw upon in cases of sickness or other disaster. The services of a physician, the free use of a library, the opportunity to play pool or billiards in a well-lighted and well-ventilated room at a nominal cost, are indirect financial benefits as well as pleasures which are assuredly appreciated by any body of intelligent workmen, such as are employed by street railway companies. There is a benefit not so apparent, but equally real in the creation and strengthening of a common spirit—*esprit de corps;* a realization of common interest in a work of many details, but of common end. The gain is the greater as all employees are included, from the helper to the manager.

The perfection of army organization is where the soldiers have entire confidence in the leader, and the leader absolute trust in the soldiers. When something of the strength of all goes into the work of each, tasks are more easily done; there is more careful attention to details, a common interest taking hold beyond the working hours gives heart to labor, when the time comes.

When one remembers that in such a scheme there is no demoralizing taint of official charity and that the men are gradually realizing that in truth they are doing all the helpful work with their own money, he will realize that the moral uplift far exceeds any of the material advantages.

The benefits of the second class from these associations—those to the employer or stockholder—are not so tangible as those received by the employee, but, nevertheless, exist to a large extent and are apparent to those who are in close touch with the workings of such associations and their bearing upon the management of the company's affairs. It may be difficult to demonstrate to an outsider, or to put your finger upon particular cases where the use of the library or the association rooms or the pool tables accrues to the advantage of the company. It is unquestionably true, however, that all of these things create a certain sentiment in the mind of the employee favorable to his employers, and which in times of labor troubles, when the misguided and unscrupulous agitator attempts to cause dissatisfaction, crystallizes into a feeling of loyalty toward the company which could not have been gained in any other way.

At the monthly meetings of the Metropolitan Association, which are held in the association rooms and at which men of prominence and officers of the company speak to the men, the employer, as represented by the officials of the company, is brought into a personal relation with his employees, not as employer and employee, but as man and man, and in this way there is established a personal relation between them and a feeling of friendliness which certainly, in a large company like the Metropolitan, is not possible in any other way. As illustrated in the late trouble in Ohio which a large manufacturing company had with its men, it is possible to overdo this kind of work. When you begin to wet-nurse and patronize working men you are offending them and making trouble. The idea is to teach them to help themselves.

An interesting discussion of Mr. Root's paper was provoked, touching on various features and precautions necessary. Mr. Root said they had already begun to retire pensioners under the plan.

Prof. W. E. Goldsborough, director of electrical exhibits at the St. Louis Exposition, then made an address on the subject, and referred to plans for showing street railway traffic systems on a track of about 1,300 feet in length.

Electric Express and Baggage Delivery.

Mr. George W. Parker, general express agent of the Detroit United Railway, then read a paper on "The Transportation of Light Express and Parcel Delivery," which contained a general discussion of the various questions involved in an electric express and baggage delivery, and gave an account at length of the details of such a service as carried on by the United Railway Company. The paper included reproductions of a number of the forms used. The establishment of the electric service, said the author, is a boon to interurban towns, to which lines are being rapidly extended in all directions within a radius of from 75 miles to 100 miles, and in a great many cases reaching towns and villages which have never heretofore enjoyed a railroad connection, or at the best, in a roundabout way, entailing great delay and almost prohibitive expense. Electric service has also made next-door neighbors of communities, between which, before its establishment, even wagon communication was not satisfactory or feasible, so that the electric service may justly be regarded as the chief factor in suburban progress, though not yet a decade old.

To the lay mind, the express and parcel business of the electric line or system would appear to be an additional and profitable use of the franchise, involving no additional expense beyond suitable rolling stock and the necessary train crew, but the author's experience has been that the operating expense tends to become greater than that of the passenger service, for the latter calls for no local stations or agents, the company assuming no responsibility before the passenger has been sighted, and after he alights, while it does become an insurer of freight or express from the moment of the giving of a receipt until it has taken one, thus necessitating a salaried agent and suitable depot facilities, stationery, etc.

In addition to the foregoing handicap to a profitable operation of the express service, there is an ordinance in Detroit which prohibits the use of trailers, and worse still, which levies a tax of $1 per car per round trip, regardless of whether the car is empty or loaded. This tax is a radical departure from the good old days, when the town or its public-spirited citizens gladly raised a bonus to encourage a railroad connection, and then considered themselves highly favored.

The management of a system should show a proper appreciation of the importance of the express department and its bearing on the continued and increasing prosperity of the system in the building up of an interurban patronage, for it seems a necessary conclusion that the out-of-town dwellers will avail themselves of the mail-order and telephone facilities of the large city stores because of the convenient and speedy electric express car delivery to their doors, and the habit once formed of sending their shipments or orders via the electric express car must eventually result in more frequent trips on passenger cars for personal and wider selections of their requirements.

But it must not be assumed that all branches of the system, or even all towns and villages on a branch, warrant the establishment of an electric express service. The population, situation, products and future of each individual place, and the competition of existing steam roads, if any, also the old-established express companies, must be carefully considered. To secure and hold the favor of the public, it has been found necessary to insist upon and maintain high-class service, which means all the little details of careful handling, prompt transit and courteous treatment.

The best results can be only obtained by the employment of a traveling express agent, whose special duties should be the soliciting of business and the securing of routing orders from consignees on shippers, which routing orders are instructions to shippers to forward all shipments in connection with the electric express. The author then took up in succession the various details of the express system organized by the Detroit United Railway Company. In addition to what was said in the paper, he stated that the city passed an ordinance prohibiting them from loading or unloading on the streets, compelling them to put up a depot of their own, and still further taxing them $1 per car per round trip, loaded or empty. He added that the package service had had a beneficial effect in increasing the passenger service.

The second day of the convention was devoted entirely to an inspection of the exhibits, which were plentiful and attractive. On Friday, the third day, the reading and discussion of papers were resumed. The first paper was a lengthy one by Mr. Mason B. Starring, of the Chicago City Railway Company, on "The Adjustment of Damage Claims," which subject was very exhaustively handled by the author.

Signals for Urban and Interurban Railways.

Mr. G. W. Palmer, in a paper with the above title, after pointing out the great desirability of an efficient and reliable signal system for electric railways entered into a discussion of the main features of such systems. He considers that all single-track suburban and interurban roads should adopt the best obtainable block system, together with a telephone system which will enable a despatcher to reach any car crew at regularly established stations.

A signal to be reliable and efficient should be quick and positive in action; it should be impossible to set the cautionary or permissive signal at the near end of the block before setting the danger indication at the far end; incandescent lamps should not form a part of the signal circuit, nor should the lighting and extinguishing of lamps be the only visual indication of the signal. This should be supplemented by the movement of an arm or semaphore blade which will move each time the signal is operated whether the lamps burn or not. The device will then be operative if the lamps burn out, as sometimes will happen. Manual control affords unauthorized persons a chance to interfere with the signal, and should not be depended upon; the setting and clearing circuits should be closed automatically, and when the signal has been set at danger it should lock so that it cannot be cleared until all cars have passed out of the block. It should be possible to set the signal only one way by two cars entering a block from both ends at the same time.

Special attention should be given to freedom from damage by lightning. As the pressure is liable to fall considerably at the ends of long lines, and also on parts of the system when heavy local loads are carried, the signal should be able to operate through a wide range of voltage, and should not be liable to damage through crossing of the signal circuit with the lines.

There are several systems now in use on electric roads, one using simply a circuit of lamps operated by a two-way hand switch at either end of the block, part of the lamps being lit as a permissive signal at the near end, while the balance indicates danger to an approaching car at the far end; this system is peculiarly susceptible to trouble from lightning, and also fails when any lamp burns out. As commonly used, the switch and lamps are in the same box, and generally the car is run into a position where the conductor can easily reach the switch. In most cases the motorman then cannot see the lamps and depends on the bell signal from the conductor.

The proper method would be for the car to be stopped at a point far enough to the rear of the box for the motorman and passengers to observe the character of the signal, the conductor going ahead and throwing the switch; where the blocks are many, this will cause an annoying delay, which could be avoided by having the switch separate from the signal box, at a point about a hundred feet to the rear of it, and at such a height that the switch cannot be reached from the ground. When permission to proceed has been obtained, the motorman should not enter the block until the conductor has struck two bells, thus making the men jointly responsible. An improved method of operating the signal is by means of a circuit closer hung overhead and at a point sufficiently to the rear of the box, the circuit being closed by the passage of the trolley wheel; there are devices of this kind now obtainable which are reliable and effective in action.

A better system is one which uses a setting and clearing circuit separate from the lamp or semaphore circuit; most of these, however, can be cleared by the passage of any one car out of the block, and in case of running several cars together, all trolleys but the one on the rear car must be pulled down when passing the switch or if the leading car clears the block the car proceeding in the other direction must be notified of the number of cars following; this is an element of danger, as it should be absolutely impossible to clear a block while any car remains. Some device should be used which will record the number of cars entering the block from either end, and hold the setting circuit closed until all cars have passed off the block. It should also be possible to clear the danger signal from both ends of the block, as it is often necessary for a car to leave a block from the same end at which it entered.

There are certain single track blocks on the Old Colony system which are operated by means of what is locally known as the "red stick." This is a small club or billet of wood painted red, which controls the block to which it belongs, and no car is allowed to enter the block unless it carries the "red stick,' it being replaced by a red lantern at night. This is a safe but not very flexible system, the absence of the stick showing one that there is a car on the block, but not the direction in which it is going. Nor does it show when the block is cleared from the other end. In case of delay or blockade of cars going in the opposite direction the stick could not be carried back and all cars going in the same direction as the one which first entered the block would be held up. It does prevent effectually the "bunching" of cars at one end of the line.

There has been some work done along the line of cutting off the trolley current from a car which has not the right of way, thereby making it impossible for the car to proceed. This scheme seems to be a very attractive one, and it is possible that it may be effectively developed.

Discipline of Employees by the Merit System.

In a paper with this title, Mr. W. A. Satterlee gave an extended account of the system in use by the Metropolitan Street Railway Company, of Kansas City, Mo. This is an application of the merit system, in which a debit and credit account is kept, violations of rules being charged against the employee by a certain number of demerit marks, and merit marks are given for acts performed which are considered by the company as worthy and deserving of recognition. If at any time within one year the demerit marks exceed the merit marks by a certain number fixed by the company, then the party receiving them is liable to discharge. A list of violations of rules with the number of demerits for each is posted in frames at each reporting place, in order that the men may know in advance the penalties; and also a list of acts considered worthy of merit with the number of merit marks given for each. Whenever demerit or merit marks are given, a notice is sent to the subject notifying him of the fact, and a duplicate is posted at the same time at the reporting place. Whenever a man's demerits exceed his merits by 100 he is liable to discharge. The paper gives a list of several hundred offences and meritorious acts, each item being accompanied by the number of demerit or merit marks accorded.

There are many trivial acts, small in themselves, committed by trainmen in handling passengers, that as a whole tend to produce a feeling on the part of the traveling public, either favorable or unfavorable to the company, which once formed is hard to offset. Small acts of courtesy toward passengers by trainmen are felt by the management in ways unknown to the men who perform these acts, and are as far-reaching for the good of the company as small acts of discourtesy are damaging. To teach employees to be guarded in their talk, their acts, and their deportment on duty toward those with whom they come in contact, is a problem nearer solved by the merit system than in any other practical manner.

The Steam Turbine; Its Commercial Aspect.

was the title of a paper read by Mr. Edward H. Sniffin, in which the author gave considerable detailed information relative to turbine plants now in operation, and discussed the cost of turbine plants and operation as contrasted with ordinary steam plants. In units as small as 400 kilowatts output, an economy may be obtained of 14.47 lbs. of steam per brake horse-power per hour, corresponding to less than 13¾ lbs. per indicated horse-power-hour. It is thus evident that moderate sized plants may with the turbine be sufficiently subdivided to give the maximum flexibility of service, with reserve, and yet possess an efficiency heretofore identified only with very large units. Further than this, a fluctuating load is not incompatible with high economical performance. As the units become larger, the turbine is then brought into comparison with the best steam engine practice, where it still preserves its uniform efficiency, and where its practical advantages are no less evident. In a recent instance, a result of 11.7 lbs. of steam per electrical horse-power per hour was guaranteed on a turbine-generator of 750 kilowatts capacity, corresponding to about 10.17 lbs. per indicated horse-power-hour, which, though the size is moderate, is, perhaps, within the ability of but few engines of any size or type that have ever been built.

Curves were displayed which indicated that the turbine requires about 80 per cent. of the space needed for the vertical reciprocating engine, and not over 40 per cent. of that wanted for the horizontal. The vertical engine compares less unfavorably with the turbine than might generally be supposed, while the horizontal engine curve is about where one would expect to find it. The latter is not carried beyond 2,000 horse-power, this type of engine being practically limited in size to that required for the 1,500-kw. generator.

Another set of curves showed the cubic yards of foundation material required, which was stated to be a more exact and striking comparison. The turbine would appear more advantageously still, if the actual foundations needed for stability had been computed. Instead, the foundations in all three cases were figured at 15 feet depth to give space underneath the engine-room floor for condensers, etc., though for large engines this depth is usually inadequate. The only foundation needed for the turbine is that necessary to hold its weight, as if it were a tank or some other stationary affair. It does not even require foundation bolts, there being no vertical or horizontal thrusts to be resisted. Comparing again the 1,000-kw. units, it is found that in actual foundation volume required the ratio of the turbine to the vertical and horizontal engine is that of 1 to 9 and 1 to 15, respectively.

Comparisons were given also on the basis of cost. In the case of foundations, the basis assumed was $7 per cubic yard for concrete, laid. While the turbine seems to average a foundation cost of about 50 cents per horse-power, the vertical engine in the more frequent sizes is approximately $1.50, while the horizontal is not far from $2.50, not forgetting that all three foundations are figured of equal depth—15 feet— to provide space below, as before stated. In the instances where special foundation work is required, such as piling or otherwise preparing suitable bottom, or shoring up building walls to enable sufficient depth of excavation, the expense avoided by the use of turbines is obvious.

In a showing of the comparative engine-room building cost, the basis assumed was 15 cents per cubic foot of space inside of walls. The building cost for the turbine is about one-half of what is required for the horizontal or vertical engine, the latter two, apparently, not being far apart. Exigencies favor the turbine, because of its smaller size and rectangular proportions, and it not infrequently happens that increased power may be supplied by locating the turbine in existing space, whereas an engine would necessitate building extension, and, perhaps, the purchase of additional land. An instance of this kind arose at Akron, Ohio, where in the existing space no arrangement could be devised to accommodate additional engine equipment. It was found possible, however, by rearranging auxiliary apparatus, to provide space for one 750-kw. and one 400-kw. turbine-generator outfit, which will shortly be in operation.

Several actual cases were cited to show the saving in cost. A plant was recently laid out to contain three 1,000-kw. units, with vertical cross-compound Corliss engines. Subsequently three more 1,000-kw. units were contracted for, steam turbines being ordered. It was found that the turbine saved 900 square feet of engine-room floor space and about 38,000 cubic feet. Had the whole plant been originally designed for turbines the saving of space would have been double these amounts, and the cost of land, building and foundations been reduced about $50,000.

An electric railroad plant in Ohio was some time ago installed, in which there are 500-kw. generators direct-connected to cross-compound Corliss engines. Space was provided for two more units of the same size. For the increased power two 1,000-kw. turbine outfits were purchased, which will go in the space left, and leave room for another turbine of 2,000 kilowatts. Thus, the engine-room space planned for 2,000 kilowatts is found sufficient for 5,000 kilowatts. It is estimated that the boiler-plant extension will be reduced about one-third, because of improved efficiency. It is figured, too, that a saving of $2,900 was effected on each 1,000-kw. foundation.

One other case, of perhaps greater interest, recently came to notice, that of a plant of 8,100 kilowatts capacity, laid out on modern lines, employing vertical cross-compound condensing engines. There is no space for additional engine power, and any increase would require building extension and encroachment upon valuable land. It was shown that without going beyond the present building walls, and without disturbing the existing machinery, the plant might be doubled in capacity by installing turbines in the space available below the present engine-room level, and adding another deck of boilers. And it has been figured that this arrangement would effect a reduction of over $3 per kilowatt per annum in the present interest charge.

As to the cost of the turbo-generator outfit itself, it is stated that its price is reasonable; that, indeed, where the comparison is fair, the turbine will require the lesser first investment. The larger field for the turbine begins about where the high-speed engine leaves off. Its steam economy at once identifies it with the most efficient engine practice, and it therefore applies more appropriately to the classes of service where medium and large-size units are used. The comparison, then, lies generally between the turbine and the slow-speed engine. It remains merely to take an engine and generator of good construction, bring the engine efficiency as nearly as possible into parity with that of the turbine, also having it possess the same overload capacity, to find that the turbine is reasonable in price. And when one adds the possible saving in foundations, buildings, etc., the first cost of installation will usually be found to be much in favor of the turbine.

At the annual election the following officers were chosen: President, Jere C. Hutchins, president Detroit United Railways, Detroit; first vice-president, W. Caryl Ely, president International Railway Company, Buffalo; second vice-president, W. Kelsey Schoeff,president Cincinnati Traction Company, Cincinnati; third vice-president, P. S. Arkwright, president Georgia Railway and Light Company, Atlanta. Executive Committee H. H. Vreeland, president Metropolitan Street Railway Company, New York; R. T. Laffin, general manager Worcester Consolidated Street Railway Company; Andrew Radel, vice-president Middlesex and Summerset Traction Company, Bridgeport; Walter P. Read, vice-president Consolidated Railway and Power Company, Salt Lake City; Willard J. Hield, general manager Twin City Rapid Transit Company, Minneapolis. Secretary and treasurer, T. C. Penington, treasurer Chicago City Railway.

Abstracts from Foreign Contemporaries

Apparatus for Testing Oils and Bearings.—There is apparently little connection tween the use to which oil is put and the usual methods of testing the same. To overcome this, and at the same time to develop a method which would enable oil to be tested with little expenditure of time, has been the object of the oil tester, shown by Fig. 1 herewith, and described by G. Dettmar in a recent issue of the *Elektrotechnische Zeitschrift*. The apparatus consists of simply a specially designed bearing, which to insure a uniform thickness of the film of oil, constitutes the only bearing necessary to make the test. The desired pressure on this bearing is obtained by mounting on the ends of a suitable shaft two heavy discs, by varying of which any pressure may be obtained. The diameter of the shaft in this case is 30 mm., which with a speed of 2,000 r. p. m. gives a circumferential velocity of 3.14 meters per second. This is considerable above the normal, so that tests of any practical velocity are easily within the range of the machine. The method of operating the apparatus is to bring it up to a speed of 2,000 revolutions, disconnect the driving mechanism, and read the speed from time to time until the machine comes to rest. The length of time that the machine revolves after being disconnected gives a figure which is inversely proportional to the friction constant. This friction constant, it may be added, is equal to $C\sqrt{r.\ p.\ m.} \div time$ in seconds, C being a constant. For testing various samples of oil it is unnecessary to dismantle the machine if the bearing is flushed out with benzine and dried before testing the next sample. In testing bearing metals, the different bearing sleeves are made in two or more parts. These can be adjusted to the shaft at the same pressure, and necessarily with the same oil will give the same thickness of film. Since the resistance coefficient is inversely proportional to the thickness of the film, slight differences in the radius of curvature of the bearings will be compensated for. The advantages claimed for this apparatus are: Simple construction; simple operation; very accurate and quickly obtained results; many kinds of oil may be tested without dismantling the apparatus; it permits of the study of bearing metals, and enables the station to keep a running record of the oil supply. The table herewith gives the results of tests made with different oils. Here T is the time in seconds that the machine ran after being disconnected, r the friction constant, t the temperature, P the price of the oil per kilogram in dollars, rP the product of the second and fourth columns, and Tr the product of the time and the friction constant. This product should be the same for all of the oils, and the tests show fair accuracy in this respect. It is evident from the tabulated results that the price of the oil is no criterion of its value as a lubricant. It happens that the cheapest oil made the best showing as a lubricant, and that the next best was also the most expensive save one. By the use of this apparatus the electric works of W. Lahmeyer reduced their expenditure for lubricants by $500 in one year.

Test	T	r	t	P	r.P	T.r
I	560	0.05	33	.08	.004	2.80
II	385	0.068	40.8	.16	.011	2.62
III	339	0.081	40	.16	.013	2.82
IV	294	0.088	39.2	.11	.010	2.70
V	289	0.091	40.5	.08	.007	2.63
VI	274	0.095	42	.12	.011	2.60

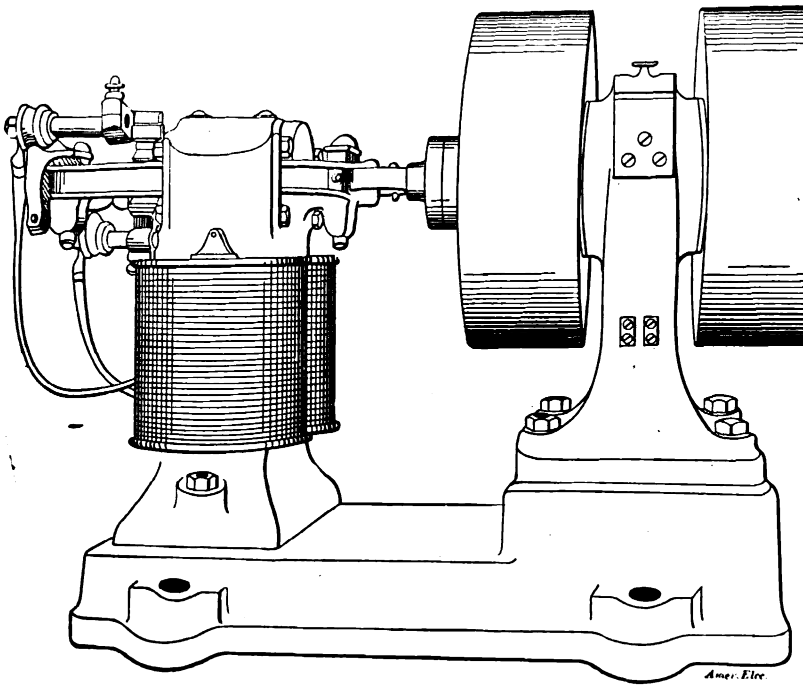

FIG. I.—OIL TESTER.

Safety Dress for Electricians.—In a recent issue of London *Engineering* is a description of a safety dress invented by Prof. Artemieff for the protection of electricians and others working around high-tension apparatus. The dress is constructed of fine but thickly woven wire gauze and covers the feet, head and hands. It is stated that the dress was tested in the high-tension laboratory of Siemens & Halske, and that throughout the tests the experimenter declared that he did not feel the slightest sensation of any current through his body. The total weight of the dress is 3.3 lbs., its resistance from hand to hand .017 ohm, and its capacity varies from .0002 up to .0025 microfarad. according as the wearer is far away from or near to a wall. The cooling surface is such that a current of 200 amperes can pass through the dress for some seconds from hand to hand without any perceptible heating effect. Standing uninsulated on the ground and clad in this garb the experimenter drew sparks from the secondary terminals of a transformer which was developing 75,000 volts at a frequency of 50 cycles per second. He next seized the main, and when the potential was raised to 150,000 volts he drew sparks from both terminals and handled the latter. The machine supplying this transformer was of 170 kilowatts capacity. In concluding the experiments the inventor short-circuited this generator by touching both of the terminals, the potential difference between the two being 1,000 volts, and the current 200 amperes. The circuit was broken by simply letting go of one of the terminals.

New Method for Starting Induction Motors.—A recent issue of the *Elektrotechnische Zeitschrift* contains an article by A. Schwartz on a new method of starting induction motors. This question has received considerable attention of late, and there are at present besides the method under discussion, three others in use for starting single-phase induction motors. One of these consists in adding an auxiliary winding and placing it ninety degrees from the main winding, throwing it in circuit by a starting switch. This winding is so designed that it causes a lag in the current passing through it, thus producing a very unsymmetrical rotating field. When the motor has reached its normal speed, this auxiliary winding is cut out. In another method the rotor is given a winding and commutator similar to that of a direct-current machine. This winding is either connected in series with the stator winding or short-circuited through properly placed brushes. Either of these methods gives a good starting torque, but with a considerable consumption of current. In still another method the motor is started by hand, or in any other way, unloaded, and when it has reached its normal running speed, a centrifugal clutch connects it with the driving shaft. The drawback in this method, however, is that the clutch frequently throws the motor into gear before the latter has reached its normal speed, with the result that it comes to a standstill. The method described by A. Schwartz makes use of the property of the alternating field to repel a conductor if placed unsymmetrically in this field. In its normal position the rotor of an induction motor is placed symmetrically, as shown by Fig. 2, so that this repelling force is not evident. By shifting it axially, as shown by Fig. 3, and connecting the stator winding to the supply, a strong repulsion becomes evident. With the rotor in this position it can be started by hand, a slight effort only being necessary. It will then come up to speed, the repelling forces of the alternating field being greater at this time, owing to the heavy current flowing in the short-circuiting ring, than the attraction of the magnetic field for the iron core of the rotor. When, however, the rotor has reached its normal speed, the current flowing in its windings is considerably less than at starting, and the attraction of the magnetic field for the core of the rotor is greater than the repelling force acting upon the rotor windings. The rotor is then drawn strongly back into its normal position. This motion is made to effect the coupling of the motor to the driving shaft. The coupling, a cross-section of which is shown by Fig. 4, is attached to the end of the rotor shaft, *W*, which is extended for this purpose, and sufficient end play allowed between the bearing for this motion and the rotor. The pulley, *R*, connected to the load is loose upon the shaft. When, now, the rotor is drawn into its normal position, the coupling, *S*, engages with the under side of the pulley *R*, the shoe, *B*, pressing against the surface *C* by the combined action of the spring *G* and centrifugal force. The action of this arrangement is claimed to be very sure, since the act of coupling does not depend so much upon the motion of the rotor as upon the relative forces acting upon this. The rotor is not drawn back into its running position until the current in its windings has diminished sufficiently to allow the attraction of the field to overcome the repulsion exerted on the windings. Fig. 5 shows the position of the coupling when

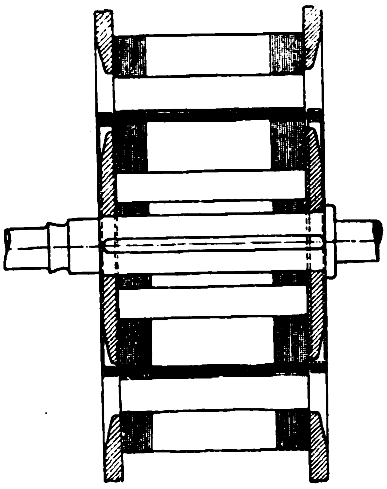
FIG. 2.—ROTOR IN NORMAL POSITION.

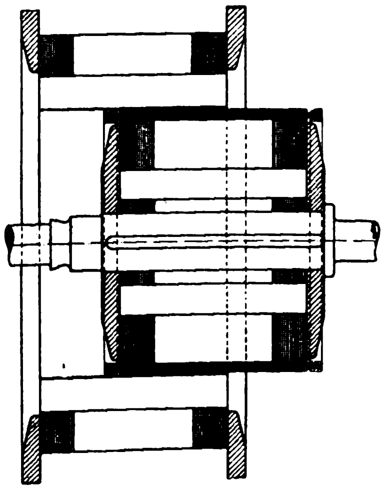
FIG. 3.—ROTOR SHIFTED AXIALLY.

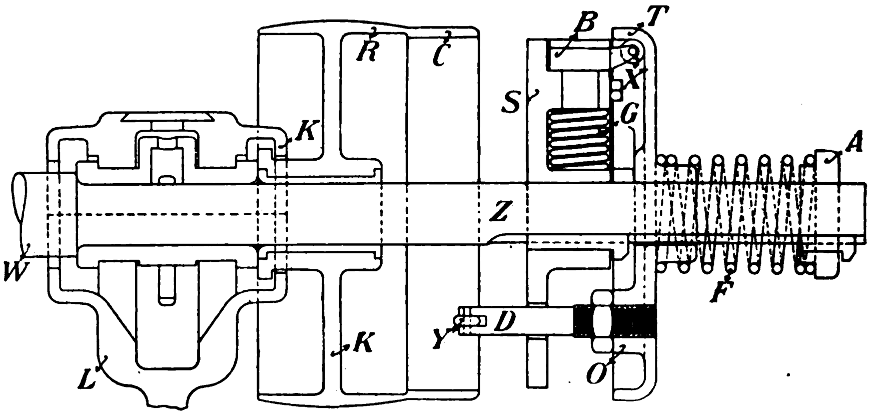

FIG. 4.—CROSS-SECTION OF COUPLING.

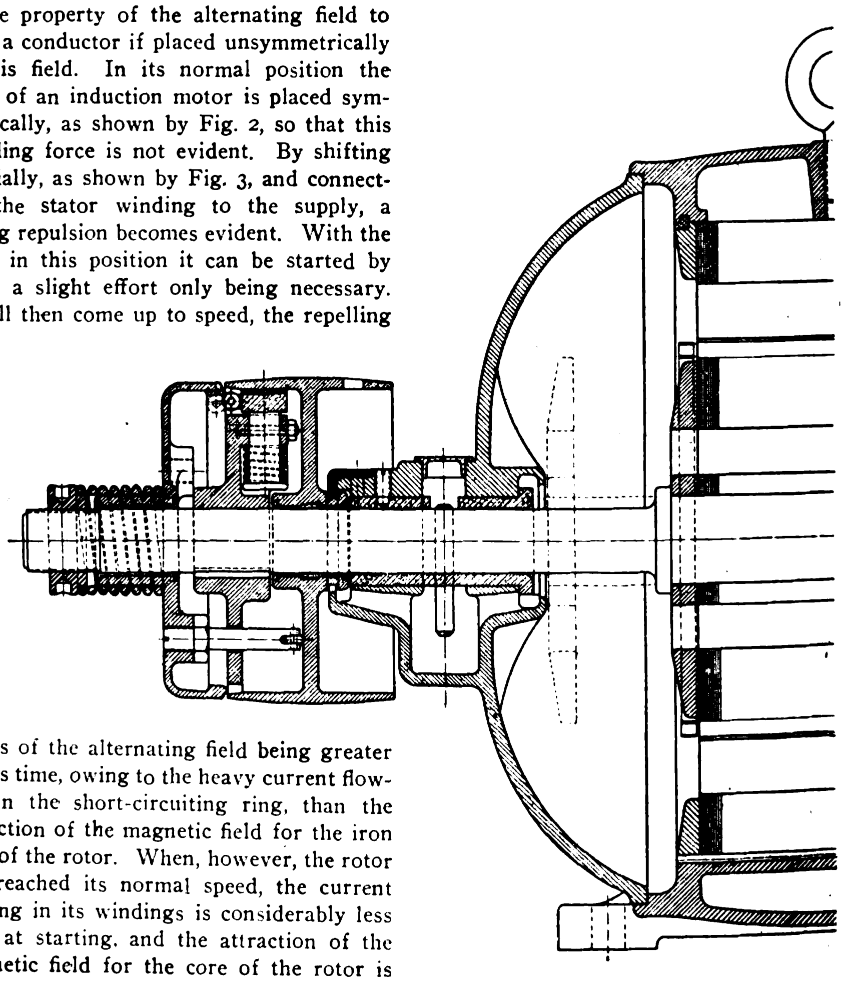
FIG. 5.—COUPLING IN POSITION.

the motor is under working conditions. In starting the motor, the rotor is pushed axially a short distance, the main switch closed, and the rotor given a slight motion by hand. The motor at once runs up to speed, automatically throws its coupling into gear and picks up the load.

Burnand Transformers.—*The Electrician* of London contains an interesting description of the Burnand transformers, which are now being placed on the market and which embody interesting departures in transformer design. One of the features that will be noticed in the transformer is that the coils are of triangular cross-section and are on four sides of an iron square built up of stampings. The makers contend that the advantage of this lies in the large surface exposed, the small radial depth of coil and the shortness of the electrical circuit without increase in the length of the magnetic circuit. This is explained as follows: The effect of the windings is simply proportional to the number of turns enclosing a given magnetic flux, and has nothing to do with the diameter of the coils, so that the shorter the length of wire required to get a given number of turns, the smaller will be the resistance and the energy lost in the coils. The reduction in the length of wire required to obtain a given effect in the Burnand transformers is shown in the diagrams given by Fig. 6. The upper right hand diagram shows a coil with parallel sides around a core having a divided return path, the diagram showing the shortest possible electrical circuit combined with the shortest possible magnetic circuit. To the left of this diagram is shown one of the stampings. The only way in which the average length of one turn of winding can be reduced from that shown is by increasing the height of the stamping, the result of which would be to increase the length of the magnetic circuit, or to save copper loss at the expense of iron loss. Adding more stampings has the effect of further increasing the length of wire per turn, thus increasing the copper loss and the drop on load.

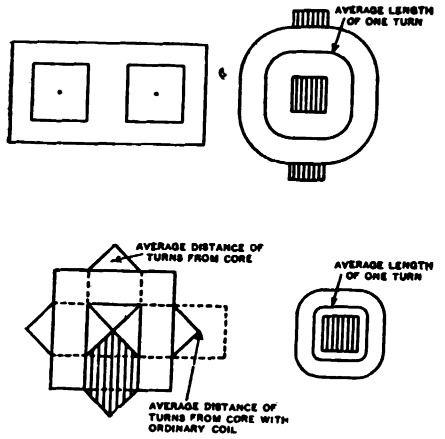
AVERAGE LENGTH OF ONE TURN
AVERAGE DISTANCE OF TURNS FROM CORE
AVERAGE LENGTH OF ONE TURN
AVERAGE DISTANCE OF TURNS FROM CORE WITH ORDINARY COIL

FIG. 6.—BURNAND TRANSFORMER.

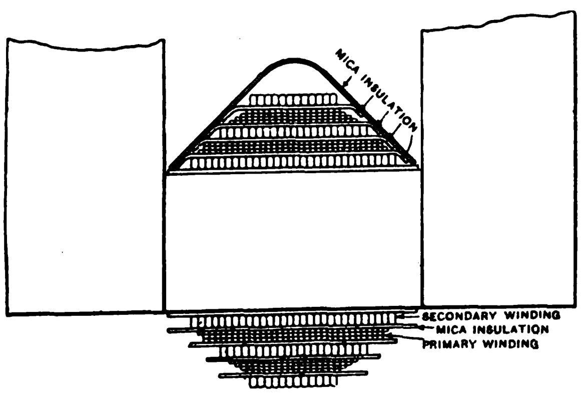

FIG. 7.—SECTION THROUGH TRANSFORMER WINDING.

The lower left hand diagram (Fig. 6) shows exactly the same core arranged as in the Burnard transformer with a single magnetic circuit and coils of triangular cross-section. As shown, every turn of wire on the coil is very close to the core on which it is wound, and also owing to the triangular cross-section nearly all the turns are in the bottom layers, the turns becoming fewer as the distance from the core increases. The net result of this is that the average length of the turns is reduced to that shown in the lower left hand diagram. This means that with exactly the same core as before and with exactly the same number of turns around the core, it is possible to reduce the length of wire in the proportion shown in the two diagrams on the left, the copper loss and drop in voltage being reduced in the same proportion. It is further claimed for these transformers that they possess a much greater radiating surface than the average transformer, which, in conjunction with the small radial depth of the coil, ensures that the middle of the coil is little hotter than the outside. It is also claimed that the regulation on motor loads is in every case as close as on non-inductive loads. A test recently made is said to have given a drop of 2.25 per cent. on full load with both lamps and motors, and it is also stated that a larger transformer made for low regulation gave 1.7 per cent. drop on full non-inductive load and 1.6 per cent. on full inductive load, the power factor of which was 0.70. The insulation consists of micanite placed around the core and windings, the edges of insulation projecting well beyond the windings. Movement of the winding sidewise on the insulation is prevented by the mutual support between the triangular coils inside the iron square. With this construction every layer is visible after the coil is completed, and in case of injury any section may be replaced without disturbing the other sections.

New Enclosed Arc Lamp.—The London *Electrical Review* describes an enclosed arc lamp which the British Thomson-Houston Company has brought out for single operation on high-voltage direct-current circuits. The lamp is claimed to be quite as efficient as the long-arc lamp and to give a perfectly white light equal in quality to that of the standard 5-ampere 80-volt arc. To obtain these advantages the voltage is divided equally between two arcs. The standard lamp takes 2¾ amperes and the two arcs are in series with 80 volts in each arc. The controlling mechanism is very simple, consisting of a steadying resistance and a pair of magnets connected in series with the two arcs across the 200 to 250-volt line. A single armature operates the clutches for both carbons, so that both feed together, rendering it impossible for one arc to rob the other to any appreciable extent. The carbons are placed very close together, so that to the observer the effect is the same as if the light emanated from a single arc. Eleven-millimeter carbons are used, and with 12-in. upper and 5-in. lower carbons the lamp is said to burn 130 to 150 hours with one trimming. The lamps are waterproof and have solid copper casings. No sliding contacts or springs are used, and all parts of the mechanism are easily accessible for inspection or repairs.

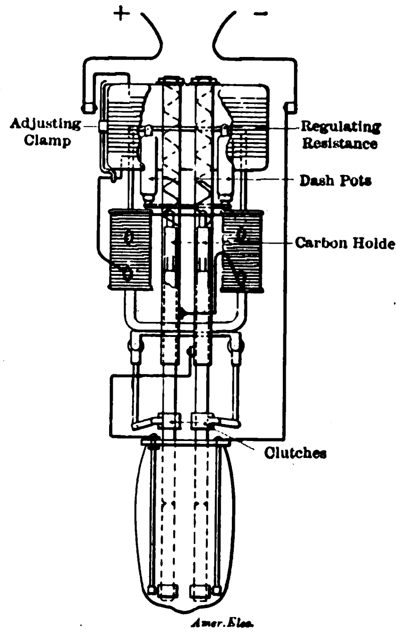

FIG. 8.—ENCLOSED ARC LAMP.

Trolley Wire Emergency Joint.—Fig. 9, taken from the London *Electrical Review*, shows a patent sleeve or muff for rapidly repairing broken trolley wires. All that is required is that the repair wagon be provided with a supply of these, and with a set of right and left-hand screw dies. On arrival, a thread is cut on the broken trolley wire ends, and these are coupled together by the sleeve, which may be tightened up with a spanner, flats being provided on the sleeve if desired. Solder can afterwards be poured in through the hole provided, as shown in

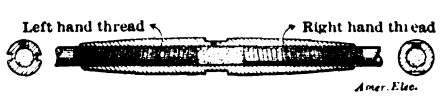

FIG. 9.—TROLLEY WIRE EMERGENCY JOINT.

the sections. The flat surfaces should be left in a side position in order not to interfere with the free running of the trolley wheel on the under side. A convenient tool would, of course, be employed to pull up the wires and prevent the two ends from rotating while the sleeve was screwed on. Although it is somewhat difficult to cut a good thread on copper, the device appears to be well adapted for its purpose, and could probably be left in position for a long period if necessary or until a convenient opportunity was found for permanent repairs to be effected.

Some Recent Electrical Patents

Multi-rate Metering System.—Two-rate meters combined with a clockwork arranged to change the meter rate at certain predetermined points of each day's run have been known to the art for some time. The only objection to such an arrangement lies in the periodical attendance required by the clock, and in order to eliminate this objection, Mr. Eustace Oxley proposes to substitute a small motor and circuit-controller for the clockwork. Fig. 1 herewith illustrates the system. The familiar Thomson recording watt-hour meter is shown at the top of the diagram; its armature circuit is provided with an extra resistance, *R*, and this resistance is short-circuited intermittenly by the wheel *8* and the two brushes which rest on its hub and periphery, respectively. Part of the periphery is covered by insulating material, *17*, and when this is under the brush *7*, the extra resistance, *R*, is put in circuit, and the rate at which the meter registers is thereby reduced. The wheel *8* is driven continuously by the small motor, *12*, and as the latter has a substantially constant load its speed is constant, and the wheel *8* therefore makes a revolution once a day, or at any other fixed rate that may be desired. By a suitable choice of speed and the proportion of wheel surface covered by the insulation, *17*, it is obvious that the meter's rate of registering can be reduced and restored regularly at any predetermined points of the daily run. Where a single building contains a plurality of consumers, a single motor would be employed to drive controlling wheels for all of the meters in the building. It is not stated, however, what means are available for correcting any gains or losses in speed that the controlling motor might make by reason of voltage variation on a direct-current circuit, or shut-downs. Patent No. 710,070.

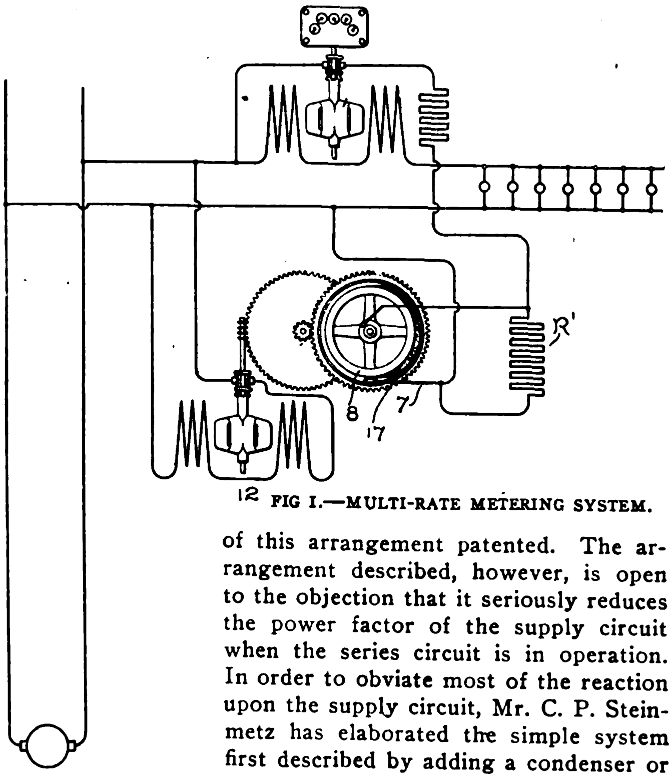

FIG I.—MULTI-RATE METERING SYSTEM.

Constant-Potential to Constant-Current System.—The transformation of constant potential into constant current by connecting a condenser and an inductance coil in series across the constant-potential mains and tapping off the constant-current circuit from the terminals of either the condenser, or the coil has been proposed, and some modifications of this arrangement patented. The arrangement described, however, is open to the objection that it seriously reduces the power factor of the supply circuit when the series circuit is in operation. In order to obviate most of the reaction upon the supply circuit, Mr. C. P. Steinmetz has elaborated the simple system first described by adding a condenser or an inductance coil in shunt to the constant-potential circuit at the point whence the constant-current circuit is supplied. Whether the added reactive device be inductive or condensive depends upon the connections of the constant-current circuit; if the latter be taken from the terminals of the condenser, then the added device must be a condenser, and vice versa. Fig. 2 illustrates the invention. In one case the constant-current (arc lamp) circuit is tapped in shunt to the inductance coil *6*, and the inductance coil *8*, is added to compensate for the leading effect of the condenser *7*, through which the arc-lamp current passes. In the other case, the arc-lamp circuit is in shunt to the condenser *14*, and the current passes through the inductance coil *13*, which causes the current to lag; this is corrected by adding the condenser *15* in parallel with the group. In the first group, the lamps are of the differential type, and in the second they are of the shunt type and steadied by the reactance *19*. The character of the lamp has nothing to do with the arrangement of the three chief reactances, *7*, *8* and *9*, or *13*, *14* and *15*, but the combination of shunt lamps and a steadying reactance in series with them is included in the claims. Patent No. 706,608.

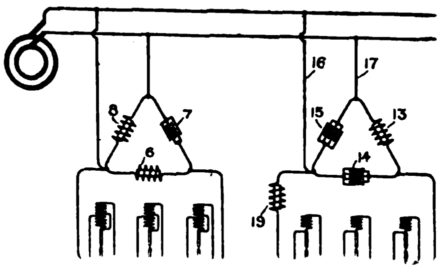

FIG. 2.—CONSTANT POTENTIAL TO CONSTANT CURRENT SYSTEM.

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NOTES.

Light Wanted by Baton Rouge.—The officials of the city of Baton Rouge, La., announce their desire for proposals for lighting streets and public buildings of the city electrically. Details may be ascertained from Mr. Edward Wax, secretary of the lighting committee.

Free Lectures.—The Board of Education of New York City is providing some excellent courses of free lectures on electricity, chemistry and other subjects, which courses are now in progress. The lectures on electricity for the current month will be delivered on each Wednesday evening of the month, at 8 o'clock, at the Young Men's Institute, 222 Bowery. In addition to this course there will be lectures on the evenings of November 7, 13, 14, 21 and 28.

Fire on a High Tension Pole Line.—Soon after the starting of the Aurora, Elgin & Chicago Railway, which is the new high-speed electric line connecting the cities named, a defective insulator on one of the 26,000-volt three-phase lines caused an electrically started fire on one of the poles, which was both beautiful and startling in its effects. The pole that took fire, instead of burning in the ordinary way with a yellow flame, was so charged with the high-tension current that the flame shot straight out from the pole in all directions, and was of a bluish tinge. The burning took place very rapidly, and was accompanied with a roaring sound. The influence of the static charge which the pole had received evidently drove the flames out at right angles to the pole, and this together with the leakage from the lines through the pole was also probably the cause of the bluish color of the flame and the roaring. The pole was burned to the ground within a very short time. But little disturbances was noted on the ammeters on that feeder at the power house, so the volume of current escaping to ground over the pole must have been very small. It has been noticed in a number of instances where leakages have produced fires over conductors of high resistance, such as dry wood or stone, that but a small amount of energy has been taken even though the disturbance at the seat of trouble was very great. In one case on record, leakage through a guy-wire on a 33,000-volt line in California to a large boulder into which the guy-wire was anchored caused the splitting in pieces of the boulder, and drops of slag oozed from it, but no unusual fluctuation of load at the power house was noticed.

A Course in Engine Room Practice.—It is announced that Lewis Institute, Chicago, in addition to the other practical engineering night school courses previously announced, will offer on Monday and Thursday evenings a course intended especially for firemen and assistant engineers who wish to advance themselves in skill and knowledge. The subjects taken up will be those most important to stationary engineers, and because of their nature, instruction must be largely individual. The large laboratory equipment including experimental boilers, steam engines, gas engines, refrigerating machines indicators, calorimeters and other apparatus is available for instruction and illustration. Simple calculations, such as are required of operating engineers, will be taken up. The instructor in charge of this course is Mr. Charles E. Manning, formerly a chief engineer in the United States Navy.

American Electrical Apparatus in English Coal Mines.—It is interesting to note that much of the electrical equipment installed in British coal mines is of American design. The Sneyd Colliery, at Burlem, Staffordshire, recently put in a complete equipment of Westinghouse alternating-current apparatus, which includes a three-phase alternator direct-coupled to a Westinghouse engine, and induction motors aggregating about 1000 horse-power. The motors are used for driving "main-and-tail" and "endless" rope hauling machines, pumps and several other auxiliaries. These mines are gaseous, and it was chiefly on this account that the use of direct-current machinery was avoided. The Clapwell Colliery, of Chesterfield, recently installed two Westinghouse three-phase alternators, one of 225 kilowatts capacity and the other of 20 kilowatts, together with a 6-kw. direct-current exciter. The British Westinghouse Company also furnished ten induction motors aggregating 280 horse-power. The Oxcroft Colliery, of Chesterfield, has installed two three-phase alternators, each of 200 kilowatts capacity and operating at 440 volts and 30 cycles per second. The equipment includes two exciters and thirteen Westinghouse induction motors, having an aggregate capacity of 300 horse-power. About 4000 horse-power of Westinghouse electrical apparatus is about to be installed in the several collieries owned by the Stavely Coal & Iron Company, of Chesterfield; and at the Tredegar Iron & Coal Company's collieries in Monmouth a complete power equipment is being installed, comprising two 150-kw. three-phase Westinghouse alternators, two exciters, each of 7½ kilowatts capacity, and ten induction motors ranging in size from 5 to 50 horse-power and aggregating 220 horse-power. Many other collieries have contracted for or already installed alternating-current equipment of the British Westinghouse Company, which apparatus, though built in England, is of distinctive American design.

Lectures for Steam and Electrical Workers.—The New York Trade School has just begun a series of ten lectures for journeymen steam engineers, and a similar course for journeymen electrical workers. These lectures occur every two weeks, the lectures for steam men being delivered on alternating Wednesdays and those for electrical men being delivered on alternating Fridays, at 8:15 p. m. The first steam lecture was delivered on Wednesday, October 22, so that the next one of the series will occur on November 5. The first electrical lecture was delivered on Friday evening, October 31, and the next one of these series, therefore, will be delivered on Noverber 14. More complete information may be obtained by application to the school which is located on First Avenue, between Sixty-seventh and Sixty-eighth streets, New York.

Master Steam Boiler Makers' Association.—The first meeting of this Association was held in Chicago, October 9 to 11, in accordance with the announcement previously made. No papers were read at this meeting, but the proceedings were of considerable value to the particular branch of industry of which this organization aims to be the exponent. Several questions were discussed more or less informally, and the following recommendations were adopted: In inspecting boilers, first the manholes and handholes should be uncovered, and after a thorough examination of the boiler within and without, the actual measurements should be taken of all braces, stays, seams, etc., and the allowable working pressure determined by means of a series of calculations formulated by the Association; the handhole and manhole covers then to be restored and the hydraulic test applied.

The factor of safety on cylindrical boiler shells to be 5.

All rivet holes to be punched 3-32 inches small and afterwards reamed to the desired size.

Tell-tale holes in stay bolts to be drilled on the outside, and the flue sheet and four or five upper rows of stay bolts to be drilled on the inside of the firebox on the side sheets.

On account of the short time available it was impossible for the Association to arrive at a definite decision in regard to stay bolt standards, beyond the adoption of 12 threads to the inch as the standard for such bolts. The delegates were requested, therefore, to consider the matter thoroughly before the next convention, so that some conclusion may be arrived at then.

The officers elected for the ensuing year were: T. C. Best, Chicago, president; William M. Wilson, Chicago; William Ord, Stratford, Ohio; F. H. Ryan, Alarmorgado, New Mexico; F. A. Mayer, Cheyenne, Wyo., and J. Wolfenden, Milwaukee, Wis., vice-presidents; George M. Clark, Chicago, secretary; J. J. Boyee, Chicago, treasurer.

Heat Engine Efficiencies.—In an interesting paper on the subject of the gas engine as a motive power, read by Professor R. C. Carpenter before the Cornell Society of Mechanical Engineers, the author made the following comparisons:

STEAM ENGINE EFFICIENCIES.

Kind of Engine.	Lbs. of Coal per H.P. hr.	Efficiency per cent.
Simple throttling non-condensing...	5	4.3
Simple automatic non-condensing....	4	5.3
Compound condensing slide valve....	3	7.1
Compound condensing Corliss..Aver.	2½	8.5
Compound condensing Corliss..Best	2	10.6
Triple condensing ....Aver.	2	10.6
Triple condensing ....Best	1¾	12.2
Quadruple condensing ....Aver.	1⅔	12.7
Quadruple condensing ....Best	1½	14.1

In the above table one pound of coal is considered as furnishing 12,000 B. T. U.

GAS ENGINE EFFICIENCIES.

Size of Engine.	Efficiency. per cent.
10-H.P.	15
50-H.P.	20
100-H.P.	24
600-H.P.	27
800-H.P.	28

The above tests give results with natural gas.

Mr. Carpenter also pointed out that the objections which had prevented the universal use of the gas engine due to its uncertainty of operation now applied to only a very small degree, and expressed the belief that in the early future the gas engine will become the almost universal motive power for such places or classes of work as require less than 100 horse-power, and which cannot be easily or cheaply reached by electrical transmission lines. He expressed some doubt, however, that the gas engine would ever compete for the supply of large power to such an extent as to essentially affect the business of manufacturing steam engines, but thought that this competition might react to induce further improvement in the art of steam engine building.

EFFICIENCIES OF OIL ENGINES.

5 to 10-H.P.	8 to 12 per cent.

EFFICIENCY OF GASOLINE ENGINES.

5 to 10-H.P. 4-cycle Engines 16 to 20 per cent.
5 to 10-H.P. 2-cycle Engines 8.5 to 10.5 per cent.

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Watt-hour vs. Ampere-hour Meters.

When the integrating watt-hour meter, carelessly termed wattmeter, first appeared there was universal rejoicing under the impression that the problem of charging a consumer for what he actually got had been solved. The application of the meter, however, developed the bugbear of the small consumer with a house-full of lamps, all of which he might throw on at the most unfavorable moment; hence the recent complex systems of charging, devised with a view to equalizing the expense of production amongst all classes of consumers. But this is not the final metering vexation. The question of preference between ampere-hour and watt-hour meters for registering individual consumption has been in agitation for some time now.

At first glance, one would naturally think there was no room for argument—that the watt-hour meter must be more equitable because it covers voltage variations, and therefore credits the consumer for under voltage and credits the company for high voltage. This sounds reasonable. It has been claimed, however, by several engineers experienced in central station economics that an accurate ampere-hour meter makes these credits more fairly than the watt-hour meter. Thus, considering a 3½-watt 16-c.p. lamp burning at (*a*) 98 per cent of normal voltage, and (*b*) 2 per cent above nomal, the following results are obtained: candle-power, (*a*) 12 per cent below nomal, (*b*) 11 per cent above normal; watts, (*a*) 5½ per cent below normal, (*b*) 3.6 per cent above; current, (*a*) 3.6 per cent low, (*b*) 1.6 per cent high. It is plain that in this case the discrepancy between the actual and the intended watts is much greater than the variation in current, and the argument is that the ampere-hour measurement is more equitable than the other because it comes nearer the amount that the consumer would pay if there were no fluctuations.

If the voltage averaged up normal, *i. e.*, if it were 2 per cent low and 2 per cent high for equal periods of similar character, the difference between the two methods would be negligible, the average watt-hours being 94.05 per cent. of normal and the average ampere-hours 94 per cent, for the case cited. But no such accurate average is obtained in practice; the low voltage always occurs when the load is high and *vice versa*, so that the divergence below normal consumption (in both watt-hours and ampere-hours) is much greater than the excess above normal. Consequently the company would be given the advantage over the consumer by the ampere-hour method as compared with watt-hour measurement.

Whether or not this is equitable in practice is a rather nice problem. In the abstract, it is not strictly rational; if the station is selling power, it should be measured in watts, and if the quantity of light is made the criterion, then the meter record should vary as nearly as possible with the light. Both of these requirements are more nearly met by the watt-hour meter than by the ampere-hour meter, and the former also comes nearer to accuracy in measuring service to different consumers whose voltages may differ continuously. It is quite common to find a difference of 4 or 5 per cent between the service e.m.f. near a distributing point and that remote from it; it is evident that an ampere-hour meter cannot register correctly at both of such places. It is true that theoretically such inequalities should not exist, but it is likewise true that in practice they are frequently inevitable.

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Electric Elevator and Railway Car Control.

Elsewhere in this number will be found a description of the fundamental features of most of the modern systems of electric control for elevators driven by direct-current motors. It is interesting to note that in every case but one the acceleration of the motor is accomplished automatically, and cannot be interfered with by the elevator attendant; this is also true throughout most of the speed range in the single case forming the exception. So far as we can ascertain, no objectionable features are entailed by thus restricting the functions of the attendant to the mere starting and stopping of the motor. In a few special cases, two fixed rates of running speed are desired, and these are provided by modifying the control system so that the attendant can start the apparatus and then determine which of the two ultimate speeds it will attain, but still cannot control the rate of acceleration.

This latter feature was long ago applied to heavy railway service by Mr. Frank J. Sprague, and there can be no doubt that patrons of surface cars would rejoice greatly if it were extended to those cars. The discomfort, and occasionally peril, to which the average motorman now subjects occupants of his car when he is behind his schedule ought to be, it would seem, ample justification for the expense of substituting automatic acceleration and thus rendering imitations of the kangaroo method of progress impossible. The engineering feasibility of making such a change is no more a question for argument than was the feasibility of extending the application of electric traction from 15-ton cars to 40-ton cars; it is purely a question of money in both cases.

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Direct-Connected Units.

Notwithstanding the many discussions that have taken place in recent years concerning the direct connection of steam engines to electric generators, the method of making the mechanical connection between the two is still a moot question, except in the case of enormous units in which the engine and generator are substantially a single structure. Mounting the armature of the generator directly on a projecting end of the engine shaft gives the simplest possible resultant structure, but it involves the more or less serious disadvantage of dividing between the engine builder and the dynamo builder a most important part of the constructional work—the fitting of the armature to its part of the engine shaft. It also interferes with the use by the dynamo builder of a single standard size of armature-spider hub and bore for a given size of machine. Some builders have reduced this difficulty to a considerable extent by adopting the rather unmechanical expedient of using only one size of armature-spider hub in a machine of given output and boring the hub to fit the largest diameter of engine shaft ever used for that output, bushing the hub with conical sleeves when a smaller engine shaft is to be fitted.

The alternative method of providing the generator with an individual shaft and coupling it to the engine shaft would appear to be obviously preferable for generating units of moderate and small sizes—say, for outputs of 250 kilowatts and under. In fact, this method possesses so many and such strong points of advantage that one is tempted to advocate its adoption for units of all sizes, always excepting such huge structures as those in the Edison, Manhattan and Metropolitan stations in this city. In the first place, the use of a coupling enables each builder to manufacture shafts to his own standards, and therefore in any multiples that commercial considerations may require. It also obviates the necessity for the armature to be handled by the engine builder or the engine shaft by the dynamo builder, and thus eliminates the shipment to and fro of one of these parts, as well as all discussion of the expense of pressing the armature on its shaft. Again, this method of connection renders it practicable to remove a damaged armature and replace it with a sound one without waiting to repair the damage. This would not be necessary often, of course, and might never be, but the feature of being able to make such a change quickly should the emergency arise might easily prove almost priceless.

The chief objection urged against the use of a coupling as compared with direct mounting is the lesser rigidity of the combined rotating part as a whole; it is not apparent, however, that a coupling necessarily militates against rigidity to any greater extent than the conical sleeves mentioned above. Moreover, there appears to be no real reason why rigidity on a par with that of a single shaft common to both machines should be considered essential. The only other objection offered to the coupling is that its adds to the axial dimension of the unit, and it seems rather thankless to grudge this extra space, in view of the many gains otherwise that are obtainable. The fact is, there is altogether too strong a tendency now-a-days to skimp in the matter of space occupied by machinery. There is no investment that yields a better return than money spent to secure ample "elbow room" around important machines which require regular attention and occasional overhauling.

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Distribution and Control of Electric Lights.

The chief advantage of electricity over gas as an illuminant lies, of course, in the quality of light produced; as a close second to this comes the great flexibility of distribution and control which characterizes incandescent lighting. Although the latter feature, as well as the former, was universally recognized early in the history of the industry, one is constantly confronted with specimens of work that indicate not merely a lack of appreciation of the possibilities of the art, but a thorouhgly stupid disregard of its fundamental requirements. For example, in a modern New York office building, all the lamps in two adjacent rooms are controlled by a switch in one of them. Consequently, when light is desired in the switchless room recourse must be had to the friendly offices of the occupant's neighbor. On the other hand, it frequently occurs toward dusk that the meditative soul of the switchless tenant is rudely startled by a sudden burst of effulgence unsought bv him and wholly unnecessary to his mental trend.

Still worse, the lamps in another room of the same building are controlled by a switch located in a different room—one in which there are no lamps controlled by that switch. The only ground on which an explanation of this arrangement can be based by process of reasoning is lunacy. In all cases the overhead lamps are bunched on "cluster balls" of the wretchedest type, so near the ceiling that manipulation of the socket keys would involve a highly clever gymnastic feat. The object of this disposition of lamps may or may not have been to compel a full appreciation of the location of switches, but whatever it was, the linguistic results of the combination are unfit for public discussion.

One of the commonest errors in distribution that one encounters consists in a misconception of the effect of bracket lights upon general illumination. It is frequently the case that a room of a length considerably greater than its breadth, and having a heavy preponderance of bracket lights at one end, will have a single ceiling fixture located precisely in the center instead of being nearer the other end. In such a case, the obvious procedure would be to provide two ceiling fixtures located symmetrically, so that the general illumination might be equalized. On the other hand, there are rooms of good size in which bracket lights are symmetrical and the ceiling fixtures conspicuously unsymmetrical in location. This is less common, however, as most men have an instinctive sense of symmetry when it comes to the geometrical arrangement of tangible objects; in fact, it is the tendency to symmetry in this respect which is at the bottom of most blunders in lighting distribution.

Probably the safest method of obtaining uniform illumination under all ordinary conditions is to make all general lighting indirect and to eschew the use of side lights except for purely decorative effects, in which case the escaping light rays should be of negligible intensity. Individual lighting, such as that of desks, small tables, etc., can be provided for by the use of flush sockets in the baseboard of the wall, with plug-and-cord connections to special portables which would not contribute appreciably to the general effect. This plan has been employed to some extent by at least one prominent consulting engineer, with splendid results. Indirect lighting is more expensive than direct, but there is no comparison between the results obtainable from the two methods. When direct lighting must be used, however, its chief objectionable feature—glare—may be reduced to an almost negligible degree without serious sacrifice in illumination if the lamp filaments are shielded either by frosting the bulbs or screening the lamps with opal or some diffusive type of glassware. This policy, combined with the restriction of brackets to ornamental uses, will enable one to achieve excellent practical results without delving very deeply into the science of light distribution.

WIRELESS TELEGRAPH APPARATUS.

The Coherer and Tapper.

BY WM. A. DEL MAR.

It is very easy to make a coherer that will act, but for successful signaling this is not sufficient. The coherer must be sensitive and reliable, and one that is slovenly made will act at one time and fail at another, thus rendering the whole system unreliable. The most reliable and sensitive form of coherer is that in which the tube is exhausted of air. This form, however superior it may be in operation, requires a considerable amount of skill and an immense amount of patience to make it, besides necessitating the use of a good exhausting air pump and a blow-pipe.

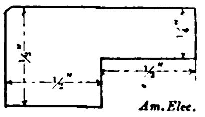


FIG. 1.—TERMINAL.

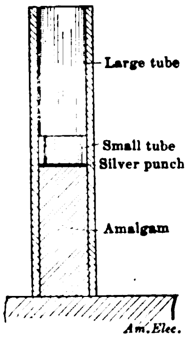


FIG. 2.

A method is here described by means of which a non-vacuous coherer of simple construction is made to do the work almost as well as its more pretentious rival. Briefly, the method consists in having a number of very simple but carefully made coherers of exactly the same construction, so made as to be easily replaced when they work badly, without undue interruption of the working. If a dozen coherers are to be made, the following materials and apparatus will be required:

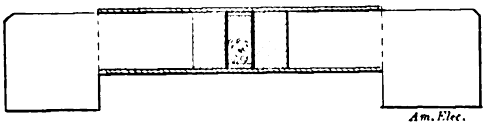


FIG. 3.—SECTION OF COHERER.

Twelve glass tubes of ¼ in. bore and 1½ ins. long; 12 glass tubes to fit fairly close within the first twelve tubes, but only ⅛ in. long; 24 round punchings of thin silver-foil nearly ¼ in. in diameter. These may be punched by means of a bill-file punch or something similar, and should be slightly amalgamated by immersion in mercury sulphate solution, and 24 pieces of 1-32-in. sheet copper of the form shown in Fig. 1.

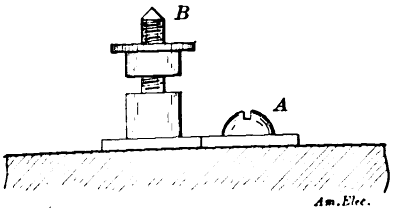


FIG. 6.

In addition to these the following materials are required: Precipitated copper; mercury; mercury sulphate; sulphuric or hydrochloric acid; silver filings; nickel filings, and a few lumps of dry calcium chloride. The only tools required are a file (rather rough); a rammer 3 ins. long, made of thick wire; a glass tube with a rubber bulb of about 2 ins. diameter, and a wide-mouthed pint screw-top bottle. The calcium chloride should be put in the wide-mouthed bottle several hours before beginning the other work, so as to thoroughly dry the air in it.

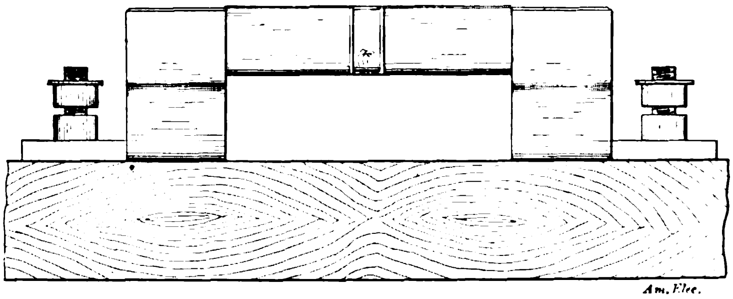


FIG. 8.—COHERER ON ITS SUPPORT.

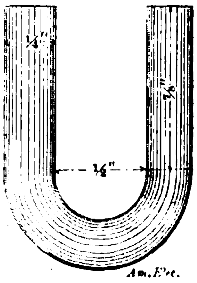


FIG. 9.—MAGNET CORE.

The fillings must be made from pure silver and nickel. Silver coins contain a considerable amount of copper, and the so-called nickel coins contain but little nickel. When the filings are made, the fine dust is removed by blowing and the two metals well mixed in the proportion of nine parts of nickel to one of silver. The file with which these are made must be boiled in a solution of washing soda before use, so as to remove the film of grease which is present on all new files. When removed from the soda solution, the file should be washed well in hot water, dried in an oven and used while still warm. These precautions may appear unnecessarily finicky, but they are really very important.

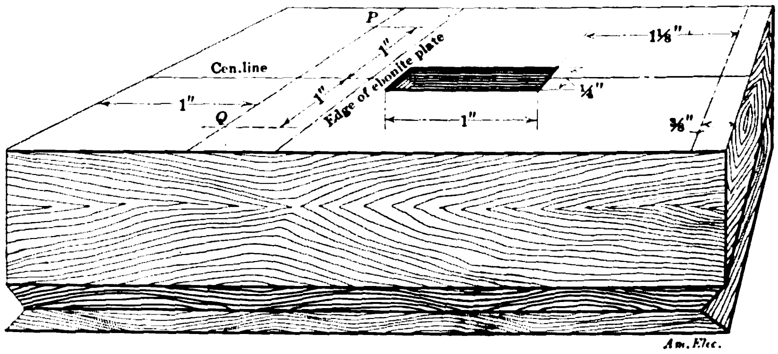


FIG. 4.—BASE.

The next step is the preparation of an amalgam from the copper and mercury. The precipitated copper may be obtained from any wholesale druggist, but it may easily be prepared in the following way. A concentrated solution of copper sulphate is slightly acidified with sulphuric or hydrochloric acid and some pieces of zinc put in it. As the zinc is dissolved more should be added until the solution becomes nearly colorless. The fluid is then decanted off from the dark brown precipitate of copper, and the latter thoroughly washed by repeated decantation with water. Some dilute sulphuric or hydrochloric acid is then poured on so as to dissolve any zinc that might remain. When every trace of zinc has disappeared, the copper is thoroughly washed in water and is then ready for use.

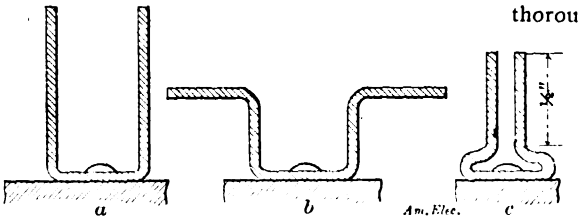


FIG. 7.

Some of this precipitated copper is put in a glass or porcelain vessel and treated with a concentrated solution of mercury sulphate. When the copper is whitened, the solution is poured off and the residue washed and dried. One part of this prepared copper is then mixed with about two parts of mercury and the mixture well stirred. This amalgam sets rapidly, so that no time must be lost in using it. Once set, it can, however, be softened by the aid of heat.

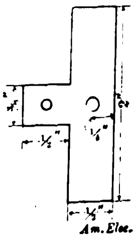


FIG. 5.

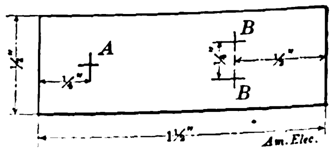


FIG. 10.—TAPPER ARMATURE.

Set one of the 1½-in. glass tubes vertically on a smooth plate and put in amalgam up to the middle. Then set one of the silver foil punchings on it and on the latter place one of the ⅛-in. glass tubes, as shown in Fig. 2. Half fill this little inner glass tube with some of the mixture of silver and nickel filings and dry them thoroughly by blowing air from the calcium chloride bottle with the tube and bulb. Then quickly set a silver punching on top of the little tube and fill up the remainder of the larger tube with amalgam. All this must be done quickly. Before the amalgam sets, push a terminal in each end, as shown in Fig. 3. The superfluous amalgam at the ends is then wiped off, and when the remainder has hardened, the coherer is complete.

The next thing is to prepare a stand of hardwood, 4 ins. x 2½ ins. x 1 in. It should be finished in accordance with the dimensions shown in Fig. 4, and finally sandpapered and varnished. The base being prepared, cut two plates of 1-16-in. copper to the form shown in Fig. 5, and fasten each of them to the base by means of a screw and nut, *A*, and a binding post, *B*, Fig. 6. This done, bend the plates up, as shown at *a* in Fig. 7, then outwards as at *b*, and finally press in the sides until the form shown at *c* is obtained. When thus completed, a coherer tube may be fitted into it as illustrated in Fig. 8.

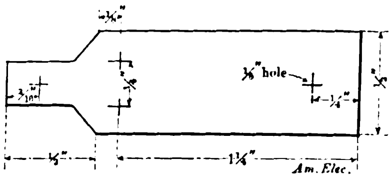
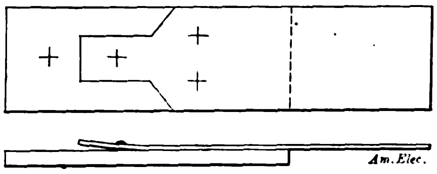


FIG. 11.—BRASS FOR ARMATURE.



FIGS. 12 AND 13.—ELEVATION AND PLAN OF ARMATURE.

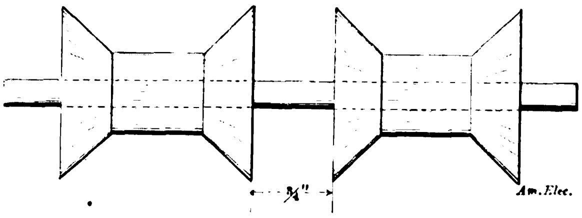


FIG. 16.—WINDING MANDREL AND BOBBINS.

The tapper or decoherer may be made next. This is nothing more nor less than a modified form of the common vibrating bell without its gong. The electromagnet is made from a ¼-in. round iron bar 4 ins. long, bent into U-shape, as shown in Fig. 9. The armature is a plate of 1-16-in. soft iron plate, 1½ ins. long and ⅜ in. wide. Fig. 10 shows a plan of the armature. Two 3-32-in. holes are drilled at *B* and threaded, and one hole is drilled at *A* and threaded to hold a good-sized binding post. A sheet of stiff sheet brass is cut to the form shown in Fig. 11. This plate is fitted to the armature so that the 5-32-in. holes match the 3-32-in. holes in the armature, as shown in Fig. 12.

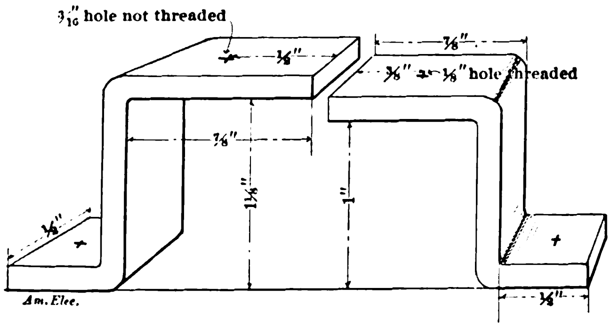


FIG. 14.—BARS TO SUPPORT ARMATURE.

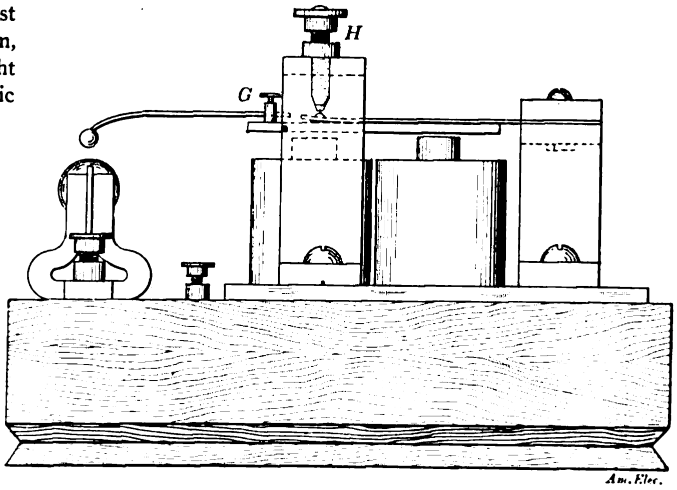


FIG. 19.—COHERER AND TAPPER.

The next step is to put a platinum contact piece on the brass strip. A piece of platinum foil ⅛ in. x ⅛ in. is all that is required. It is rolled up to a conical form and the small end passed through the hole *a*, Fig. 11, which is punched ¼ in. from the end of the brass strip. It is then hammered down so as to form a sort of rivet with the larger head outside. This done, the brass strip is bent up slightly, as shown in Fig. 13.

The two Z's shown in Fig. 14 are made of ⅛-in. sheet brass. Fig. 15 shows a brass bridge-piece which fits over the electromagnet and holds at *C* an adjustable screw and lock-nut of the form used in electric bells. This screw must be tipped with platinum, and had better be bought from a dealer in electric bell accessories.

The last part to be made is the winding. A wooden mandrel of ¼-in. diameter and about 6 ins. long is required. A common pencil of ¼-in. diameter will do. A few thicknesses of paper are wound around this and a common spool is pushed on at each end, as shown in Fig. 16. The ¾-in. space is painted with shellac varnish, and while still sticky, a layer of No. 24 double cotton-covered wire is wound on carefully and tightly. This is varnished and another layer put on. This process is continued until the thickness of the winding is 3-16 in. The varnish is allowed to dry and when dry the coil is slipped from the mandrel, varnished again and dried in a moderate oven. Two such bobbins are required. The various parts being made as just described, they are assembled as follows:

The core of the electromagnet, previously painted black, is set in the middle of the big hole in the wooden base and surrounded by plaster of paris. When the paste has set, an ebonite plate of the form shown by Fig. 17 is set over it and screwed to the wooden base by means of small screws set in the corner holes. One thickness of paper is wound round each projecting pole and stuck on by shellac varnish. When the varnish has dried, the two bobbins of wire may be slipped on, care being taken that they are so connected as to produce opposite polarities in the magnet poles when current is applied to them. The piece shown in Fig. 15 is then screwed to the

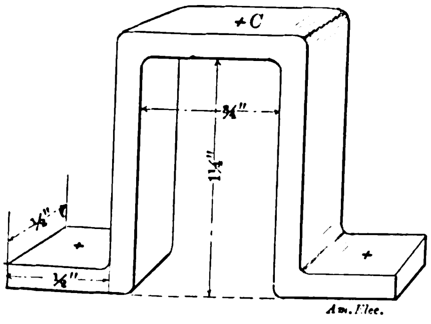


FIG. 15.—BRIDGE.

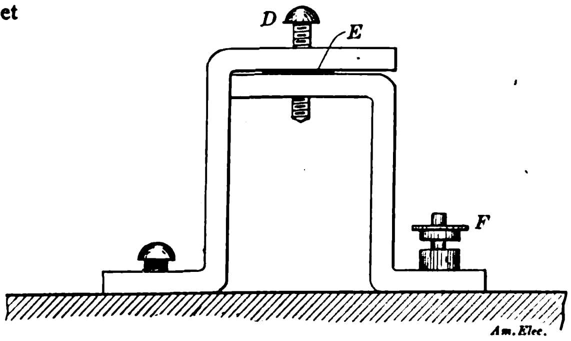


FIG. 18.—ARMATURE SUPPORT.

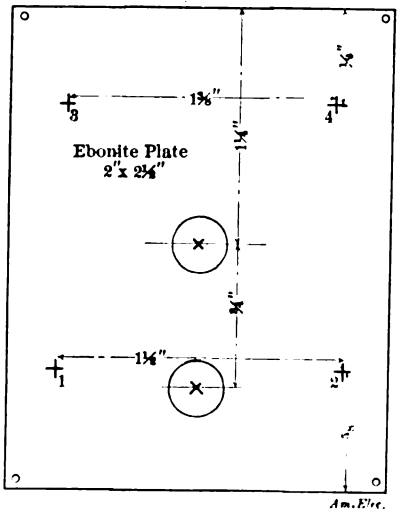


FIG. 17.—EBONITE PLATE.

ebonite plate at the holes *1* and *2*, Fig. 17, one of the screws being a binding post, and the pieces shown in Fig. 14 are screwed to the plate at the holes 3 and 4. They are set in relation to one another as shown in Fig. 18, screwed together by means of the screw *D*, and the broad end of the brass spring attached to the armature is set between the plates, as shown at *E*. The screw *F* is a binding post. When assembled, the decoherer appears as shown in Fig. 19. A hammer is shown attached to the binding post *G*, set so as to tap the coherer when the armature is in motion.

One of the terminals of the magnet winding is attached to a binding post set in the wooden base, which is one of the main terminals of the outfit. The other end of the winding is attached to the binding post *F* in the Z bar (Fig. 18), the second main terminal being the binding screw *H* attached to the bridge.

Both the coherer and tapper, with the shunts, must be placed in a metallic box. This box is made in the following way: A sheet of zinc is cut to the form shown in Fig. 20, and bent up through a right angle at each of the dotted lines. The overlapping joints are then soldered so that a zinc box, with one end open, is obtained. When all the joints of the box are hermetically sealed with solder, the box is painted black inside and out. A sheet of zinc 3 ins. x 3½ ins., also painted black on both sides, is then screwed to one end of the coherer base in such a way that when the coherer and accessories are in the box the entrance thereof is completely closed by the zinc rectangle. Four small holes are drilled in this end plate to admit the connecting wires. A handle should also be soldered to the plate to facilitate drawing out the apparatus. This completes the coherer and its attachments.

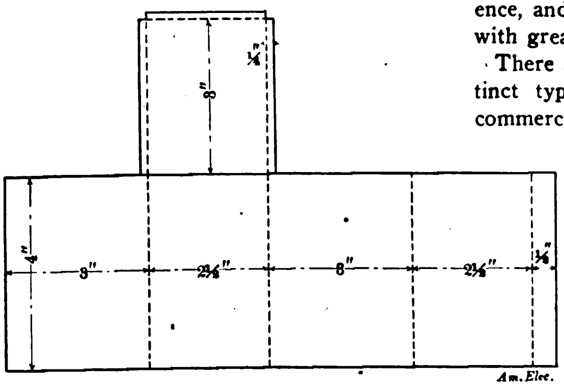


FIG. 20.—ZINC SHEET FOR INSTRUMENT BOX.

When a coherer fails to work well, the apparatus is drawn out of the zinc box, the hammer lifted, and the tube replaced by another one.

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The World's Coal Production.—According to a British exchange, the world's coal production is 700,000,000 tons annually. During the past three years the United Kingdom has produced an average of 221,441,000 tons, and the United States 242,816,000 tons. The total of these two countries amounts to nearly five-sevenths of the whole world's production.

FAULTS OF ELECTRICAL MEASURING INSTRUMENTS AND THEIR CORRECTION.

BY H. WILLIAMS.

Electrical measuring instruments are all necessarily of a somewhat delicate construction and require a certain amount of readjusting or repair, and time and money can often be saved by the users making a few careful adjustments or slight repairs, thus avoiding returning the instrument to the makers, which often means the loss of several weeks of time and heavy express charges in addition to the cost of repairs. Even when the repairs reach the magnitude of requiring new parts, it will pay to obtain these from the manufacturer and do the necessary assembling and recalibration.

While the majority of instrument makers aim to make the various parts interchangeable, this is not always possible and the maker's serial number of the instrument, together with a complete description of the desired parts should be given on the order. Careful attention to these points will avoid annoying delays and tedious correspondence, and will enable the order to be filled with greater satisfaction.

There are at the present time several distinct types of measuring instruments in commercial and laboratory use, each type being subject to certain troubles or defects that are confined to that particular design, but all subject to a general class of troubles that can be grouped under a common head and for the remedy of which general rules may be laid down. It is this class that is discussed in the present article.

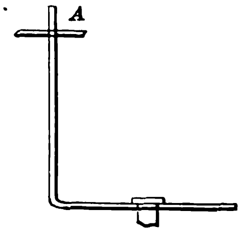

FIG. 1.

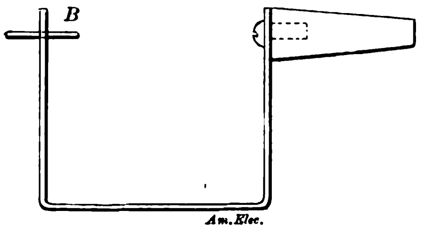

FIG. 2.

One of the more common faults and causes of complaints in electrical measuring instruments is what is known as the "zero error," the pointer or needle standing either above or below the zero mark and thus introducing scale errors. With an instrument having an evenly divided scale, a correction constant equal to the amount of zero error can be added or subtracted from the instrument indication, but this is somewhat unsatisfactory, and with instruments having a non-uniform scale, the method is far from correct.

The zero error is usually due to heavy overloads or reversals, causing the pointer to be brought forcibly against its stops or buffers and resulting in bending the needle. This fault is easily identified in one of two ways: Either by locating the bend in the pointer or by noting if the moving system stands at approximately the same place in both the horizontal and the vertical positions. To correct an error of this class the pointer should be carefully bent or twisted until it occupies the proper zero position over the scale plate.

When the pointer is broken or so badly bent that straightening is impossible, a new one should be ordered from the maker, unless the same kind and size of metal is available.

Other sources of the zero error are iron filings; small particles of fiber on the paper scale plate striking the pointer; loose threads of insulation on the armature coil winding rubbing against the field coils supports or magnet pole faces; roughened pivots or jewels, or change in the position or the strength of the restraining or controlling force.

The iron filing trouble is usually confined to the permanent magnet type of instrument, and may be easily remedied by carefully passing a thin piece of magnetized steel across the magnet pole-faces, when the filings will adhere to the piece of steel and may then be brushed off.

Particles of fiber on the instrument scale plate or detached insulation on the armature coil may be removed by means of a sharp knife, or in the latter case, by passing a small piece of heated metal carefully over the surface of the coil, thus burning off the loosened threads.

Roughened pivots or jewels constitute one of the most frequent sources of error both at zero and higher positions of the scale, and are usually caused by severe handling while in use, or during transportation. To detect this fault, the instrument should be placed in its operating position and the pointer moved by means of a pencil carefully across the scale to its maximum position, and allowed to come slowly back to rest. The scale plate should then be gently tapped or jarred with the finger or pencil, and if the pointer drops to a lower position than that at which it came to rest, it indicates that either the pivot or the jewel is damaged, and possibly both. This operation may be reversed by moving the pointer below zero, when the reverse action will take place; that is, the pointer will assume a higher position after tapping the scale plate.

In case it becomes necessary to remove the jewels, care should be taken to secure the armature by means of small paper wedges, thus preventing the pivots becoming damaged by coming in contact with the metal parts of the instrument, as a very slight shock will injure the needle-like points and introduce friction. After removing the jewel it should be carefully wiped out and cleaned with a soft cloth moistened in alcohol, after which it should be tested with a sharp needle for roughness. By lightly passing the needle over the jewel surface any roughness or cracks can be detected and if found, a new jewel should be inserted. The pivot should also be inspected, for if it has been running for any length of time on a damaged jewel it will usually be found defective and should be tested by pressing it lightly against the thumb or finger nail. If in good condition the point will stick or catch in the nail, but if damaged, it will slide along the surface and show no tendency to embed itself.

When a pivot has suffered but slight damage it may be "pointed up" or sharpened by means of a fine oil stone, but it is usually necessary to repolish the points in a lathe or small hand drill. As the majority of instruments are not provided with removable pivots it becomes necessary in polishing to revolve the entire shaft and armature, so that precautions must be taken to avoid bending or distorting any part of the mechanism.

When a lathe is available, one end of the shaft should be firmly clamped in the chuck, the other end passing through a small hole in a brass guide secured to the slide rest or tail stock. A convenient support for the first method is shown in Fig. 1, and Fig. 2 shows a support for securing in the tail stock. The holes *A* and *B* must be exactly in line with the chuck center to insure even running of the shaft and uniform polishing. The lathe should be run at a slow speed in order to avoid bending the pointer or loosening any of the armature parts, and before starting under power it should be revolved a few times by hand to see that all parts run perfectly true and free.

In sharpening, a small hand oil stone should be used and the pivots brought down to needle points, after which they may be polished with German chalk or "dimantine" sprinkled on a piece of soft leather. The armature should then be balanced so that it will assume no definite position but will remain in any position to which it is moved; this point is very essential as an instrument having an imperfectly balanced moving system can never be capable of continued accuracy under ordinary operating conditions.

For balancing the armature, a frame like that shown in Fig. 3 will be found very useful. It consists of two ⅜-in. brass rods, approximately 6 ins. in length, mounted on a suitable base and drilled near the top to receive two threaded trunnion screws, *C, D*, which may be secured by cramping screws or check nuts as one may prefer. The trunnion screws have standard instrument jewels mounted in their ends, and should be kept in first-class condition, being cleaned and renewed at frequent intervals. Balancing is accomplished by adding or deducting weight from the pointer counter balance, a convenient method being to add a little solder to the weight and make the fine adjustments by filing.

In assembling, care must be taken to wipe the pivots perfectly dry and avoid tightening the jewel down on to the points, just enough end play being left to ensure good operation and not enough to allow the pivots to leave the bearings during transportation.

Zero errors caused by changes in the position or the strength of the restraining or controlling force may be compensated for in gravity control instruments by altering the position or weight of the small counter balances. These weights are usually movable, but if sufficient adjustment is not practicable, they may be filed off or added to until the necessary range is obtained. If the weights are not movable, the counter-balance arm or wire can be slightly bent by means of pliers, care being taken to lift the moving parts off the bearings to avoid damaging the pivots or jewels.

With instruments of the magnetic control type, it is necessary with some makes to change the position of the small control pieces attached to the armature shaft, while in other forms the strength of the field must be diminished or increased by means of the keeper or iron shunt secured to the magnet poles. The latter result may be obtained by inserting very thin sheets of mica between the magnet pole-faces and the keeper.

In instruments of the spring control type, the spring may have shifted bodily on the shaft, in which case it should be reset, either by moving it back to the original position or by changing the position of the spring holder or controller. This holder is usually adjustable, and is secured by means of screws or nuts which are easily accessible.

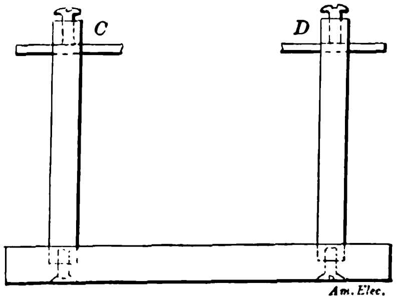

FIG. 3..

If the instrument has been subjected to a heavy jar or shock, one or more convolutions of the spring may have become entangled, which in some types of instruments will short-circuit the armature coil winding besides throwing the pointer off zero. The spring should be carefully untangled, and as symmetrically arranged as possible by means of a small pair of pliers or tweezers.

Voltmeters and wattmeters are sometimes rendered inoperative by an open-circuit in the conducting springs, armature, field or resistance coils. If the break occurs in the springs, a duplicate should be ordered from the maker, but if it is in the winding, the fault can usually be located and repaired by the exercise of a little care. After locating the break by means of another instrument or a magneto, the defective part should be removed, and if the fault is not apparent to the eye the wire should be slowly unwound, keeping count of the number of turns, until the break is located. Where several breaks occur in the same coil, it is usually better to use new wire of the same size and rewind the coil. When making joints a flux composed of resin dissolved in alcohol should be used, acid being objectionable in all cases.

Series ammeters, or those which carry the entire current to be measured, are seldom found to be open-circuited, owing to the heavy winding, but ammeters of the shunted type occasionally develop this fault either in the shunt leads or in the coil of the instrument itself. Many times open circuits are caused by binding posts or connections working loose, and such cases are, of course, easily remedied.

After the instrument is repaired it should be checked up by a suitable standard and a record made of the discrepancies found, a tag being attached to the base giving date of test and the percentage of error, this error being taken into consideration when making tests.

With voltmeters or wattmeters having a low resistance potential circuit, readings should be taken as rapidly as possible to avoid heating errors, several moments being allowed to elapse between successive readings so as to keep the coils at a uniform temperature. When the correction tag is objectionable or it is desired to make the readings check with the scale marking it becomes necessary to either alter the strength of the controlling force, or the resistance in series with the armature or active coils, and when possible the latter method is preferable.

Some instruments of the D'Arsonval or moving coil type are provided with magnet pole-pieces having two small soft iron punchings which may be moved so as to shunt more or less of the magnet flux, thus causing the instrument to read higher or lower, as desired.

The resistance in series with the armature or active coil of voltmeters and wattmeters is usually composed of very high resistance wire wound on suitable spools or tubes, and sufficient wire should be removed or added to make the necessary corrections.

The resistance of shunt type ammeters is composed of a short length of comparatively large wire of low resistance secured to a suitable support, or lying loose on the instrument case, the length of wire in series with the armature being increased or decreased by unsoldering one of the armature leads and moving it back and forth on the resistance wire; care being taken to thoroughly resolder all joints and allow them to cool before taking a reading, so as to avoid heating errors and thermoelectric effects. With some makes of instruments, the same results may be accomplished by twisting a section of the resistance wire together and carefully soldering the twist.

In recalibrating ammeters of the series type, it is necessary to change the controlling or restraining force which is readily accomplished on spring control instruments by letting out or taking up part of a convolution of the spring; on gravity control by increasing or decreasing the controlling weights, and on magnetic control by increasing or decreasing the flux shunted by the magnet keeper.

As a large proportion of instrument trouble and complaints can be traced to improper handling or installation, a few words on this subject will not come amiss.

When received from the manufacturer the instrument should be immediately unboxed, inspected and tested, so that any claims for breakage can be settled with the transportation company or claims for inaccuracy with the makers. If the instrument has separate parts, such as resistance boxes or shunts, these should be carefully searched for in the packing, as in many cases claims are made for shortage and the parts are found afterwards in the packing boxes.

Instruments of the portable type should be kept in a place free from dirt, moisture and vibration, and instructions should be issued that care must be observed to avoid subjecting the instruments to overloads or rough handling when making tests. Switchboard instruments should be permanently installed on the board as soon as possible after receipt to avoid damage, loss of parts, etc.

The directions and diagrams accompanying the apparatus should be carefully read and followed, as many instruments have been ruined by improper connections such as connecting a shunt ammeter directly across the line instead of the shunt, or omitting to connect up the external resistance box which accompanies a voltmeter or a wattmeter.

Many alternating-current instruments for high potential or heavy currents are provided with potential or current transformers; potential coils being supplied from the low potential secondary and current coils from the small-current secondary, and care must be taken to see that the connections are properly made in order to insure accuracy and avoid burning out the instrument coils.

SOME FEATURES OF OPERATION IN THE NIAGARA POWER HOUSE.

BY ARTHUR B. WEEKS.

Possibly the most important of all the experiments that have been carried on at the Niagara Falls power house during the past eighteen months was the addition of apparatus to one of the dynamo shafts; the object being to prevent the burning out of thrust bearings, which is liable to occur in winter under unfavorable conditions due to low water and the presence of large quantities of ice. As is generally known, the upward shoot of water in one of the two wheels on the dynamo shaft buoys up the revolving parts. The water may be shut off entirely while the dynamo is revolving, and no weight comes on the thrust bearing, through the intervention of this additional apparatus, which is described below.

Directly above the thrust-bearing is an oil-tight chamber, within which are two steel discs, one secured to the vertical shaft, the other to the oil chamber. A direct-current Westinghouse motor belted to a triplex single-acting Dean pump supplies the chamber as well as the thrust bearing continuously with oil, through two supply pipes. Under regular running, there is no weight on the oil between the discs; but upon the thrust bearing, as before, there is a pressure not exceeding three tons, either up or down. A pressure gauge at the pump indicates 25 lbs. in regular operation; but when the water is shut off, this pressure increases to 350 lbs. The oil from the discharge gravitates to a separator and filterer, and thence to a tank, from which it is pumped to a large oil tank near the roof of the building. From here, it again gravitates to the numerous other bearings, the process being kept up continuously. The bearing has proved very successful.

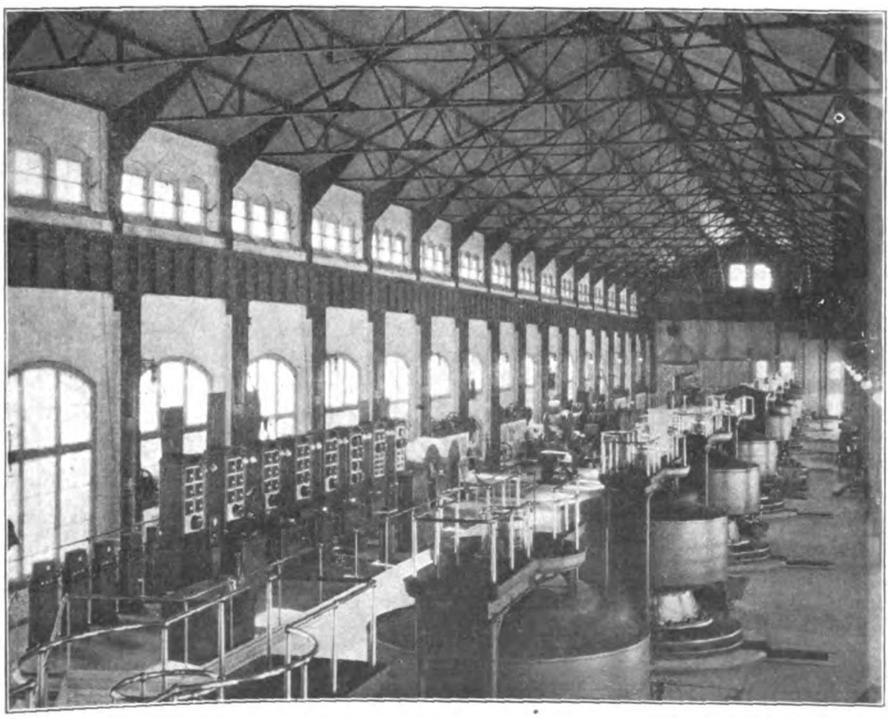

FIG. 1.—INTERIOR OF POWER-HOUSE AT NIAGARA FALLS.

The wearing away of the turbine valve, causing it to leak, has after years of constant running caused some annoyance. It is due to stones slipping in between the revolving surfaces and grinding out the metal. There is enough leakage with the valve closed to keep a dynamo running, after having been started, at least one-third of its regular speed—250 revolutions per minute. To stop a dynamo under these conditions, it is necessary to short-circuit the machine. This is done by inserting a specially made jumper into the jaws of one phase of the dynamo switch, when the switch-head has been removed to gain access to the switch jaws. The dynamo field is put on, and the dynamo begins to slow down at once, and stops in a few moments. Not until then is it safe to shut the water entirely off at the inlet gate. When the field is charged, the ammeter will register 800 to 1000 amperes on one phase, and it gradually decreases to zero.

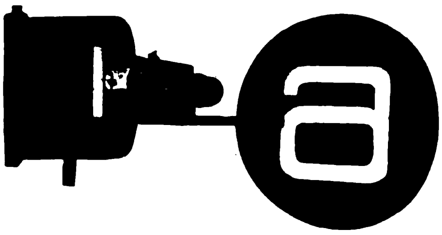

FIG. 2.—ELECTRIC SEMAPHORE.

To remove a thrust bearing, either to scrape or renew it, requires some method of relieving it of the weight upon it—about forty tons when the dynamo is at rest. To accomplish this, large cap screws are screwed down through the turbine wheel into the turbine chamber. These are set down uniformly all around, until the shaft is sufficiently raised, when the several parts of the bearing may be removed. After refitting and replacing as before, some method of turning the shaft is necessary. It must not, for several reasons, be done by means of the water; but must be moved slowly and without any undue friction or strain. It is, therefore, revolved in either of the two following ways: An exceedingly large, strong rope is passed several times around the field ring, the circumference of which is thirty-seven feet, and the rope is crossed a number of times to prevent slipping. A chain is then passed through an opening in the base of the nearest dynamo, and a powerful pulley block connected to the chain. The fifty-ton traveling crane is then run up to a point just above the pulley block. The rope from the dynamo passes around the pulley block, and is then securely fastened to the large pulley of the crane, and the powerful hoist set in motion and slowly raised, the rope tightening and stretching as the strain increases. The rope is frequently tested, the hoist being stopped for that purpose.

Unless the bearing is excessively tight, the dynamo will start. After a few revolutions, the bearings must be removed and scraped, and the process repeated as often as is necessary to get a free movement of the shaft, and the proper bearing. Even then, the dynamo is not started at full speed, but is driven several days at slowly increasing speed, until it has reached and run a number of hours at full speed. The temperature of the oil from the bearings is taken often and closely watched.

The other method of starting to mark the bearing is as follows: The penstock is filled, and enough water admitted to the turbine by the governor attendant to turn the dynamo slowly several times. Should the generator gain too much headway, the dynamo field is closed, the jumper having been previously placed in the jaws of the dynamo switch, and the speed is checked almost immediately, and stopped by increasing the field charge when necessary. Weakening the field allows the dynamo to revolve again. The voltmeters and wattmeters do not indicate the conditions at this time, but a very sensitive voltmeter should show about 50 volts.

To dry out a large generator, it may be short-circuited in this way and the field increased slowly; the speed is also brought up gradually. The generators will stand 1500 amperes per phase for some time, and have frequently carried 1000 amperes in regular operation. A code of signals is provided for use should anything go wrong in the wheelpit. In case of a dynamo being on special test, a large gong is placed beside it, and a cord extended to the deck below, or continued to the lower deck if needed there. For regular service, the electric semaphore designed by Mr. L. B. Stillwell and illustrated by Fig. 2 is a most useful device. Opposite each dynamo, mounted on the wall and visible from every part of the power house, is one of these instruments, with a number corresponding to that of the dynamo. When an accident in the wheelpit renders it necessary, an attendant in the wheelpit pulls upon a wire cable opposite the shaft of the machine that is to be stopped. This closes circuits that light the lamps upon the semaphore, and brings the target from a horizontal to a vertical position; at the same time, an electrical impulse is sent through a solenoid that opens an air valve, causing a whistle to blow. This whistle continues to blow and the lamps to burn until an attendant on the main floor pulls on a cord which resets the apparatus. The system works very satisfactorily.

To remove parts of the dynamo shaft to the top floor of the power house is no small undertaking. After removing the upper part of the dynamo and its interior castings, the shaft is taken out in sections. Every part of it must be brought up through the interior of the dynamo, and this, of course, requires considerable skill and care. The fifty-ton crane is used for the purpose.

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Cutting Carbons—Battery or other carbons can be cut with a handsaw moistened with water, or by making a deep scratch and breaking on the scratch.

LUBRICATORS FOR SPECIAL SERVICE.

BY JAMES F. HOBART.

Besides the cylinder lubricators and automatic oil and graphite cups for general serice which were described in previous articles, there are a great many oiling devices designed for special service, such as crank-pin lubrication, gas-engine lubrication, loose pulley, oiling, etc. The number of these is too large to consider every type in detail, and the author has only attempted to describe those most generally used.

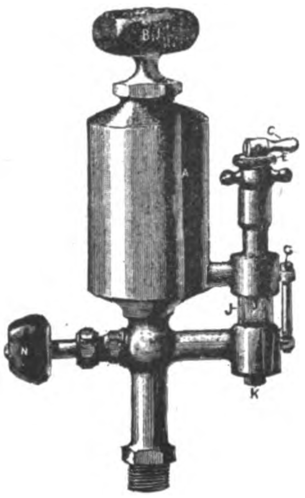


FIG. 1.

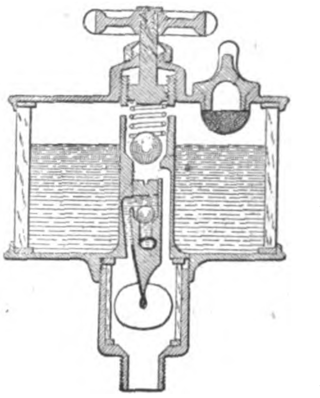


FIG. 2.

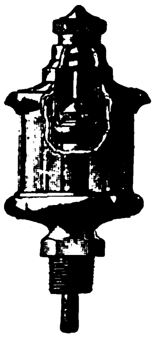


FIG. 4.

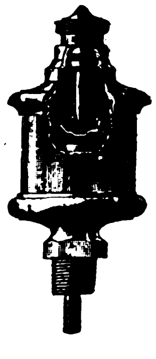


FIG. 5.

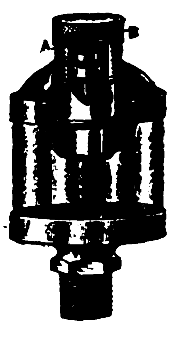


FIG. 6.

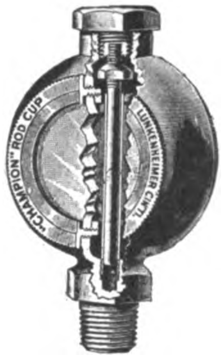


FIG. 7.

Fig. 1 represents a lubricator for gas engines, made by the William Powell Company, of Cincinnati, Ohio, and resembling in appearance a steam-engine cylinder lubricator. It is a "down sight-feed" cup, the oil being fed from the nozzle in the short glass tube *J*. The rate of feeding is regulated by adjusting the milled nut *E*, which is locked in position by a jam-nut, *D*. The feed is thrown on and off by means of the signal lever, *C*, which operates in exactly the same manner as the signal lever on the well-known Powell sight-feed oil cups. The glass tube *J* is removable through a hole in the bottom of its lower mounting, which is normally stopped by means of the plug *K*. When the cup is to be filled, the delivery outlet is closed by means of the valve *N*, and the plug *B* is removed, as in the case of the simple old-fashioned brass oil cups. Feeding of the oil is accomplished as follows: A check valve between the reservoir *A* and the delivery stem is raised by means of pressure through the stem, and as the upper surface of the valve is much larger than the under surface, the pressure within the chamber *A* immediately closes it against the pressure from the engine, and forces the oil through the side path afforded by the tube *J* and the feeding nozzle, when the pressure in the cylinder is reduced.

Fig. 2 illustrates the "Simplex" gas-engine lubricator, which works on the same principle, but is different in mechanical structure from the one just described. The intermittent applications of pressure from the gas-engine cylinder raise the large ball which is instantly seated again by the helical spring above it. The pressure within the oil chamber then forces oil into the small chamber cored into the central stem, raising the small ball-valve and delivering oil to a grated surface which allows the oil to trickle down and be fed gradually into the cylinder between the impulses of pressure.

A number of crank-pin oilers have been put on the market within recent years, among which the Nugent pendulum oiler, illustrated by Fig. 3 is one of the best known. The engraving is almost self-explanatory. The oiler is only intended for side-crank engines and consists of a sight-feed oil cup mounted on a block which is pivoted on the outer end of a pin set into the free end of a reverse crank which is attached to the main crank-pin. The block is weighted with a pendulum which is made amply heavy to keep the cup in a vertical position, regardless of the rotation of the pin on which it is mounted. The oil is fed

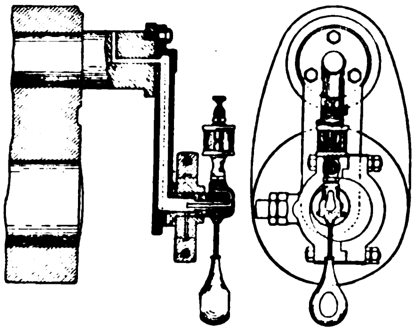


FIG. 3.

into a recess in the pin and passes down to the crank-pin every time the latter goes below the center of the main shaft. The engraving shows a small eccentric mounted on the oiler pin; but this is a feature of the engine construction and bears no relation to the oiling device.

Figs. 4 to 7 represent crank-pin oilers in which the feed is accomplished by the throwing upwards of the oil when the crank-pin changes from the upward to the downward direction; in other words, the inertia of the oil causes it to be "left behind" when the crank-pin changes its general direction from upward to downward. In Fig. 4 the rate of feeding is regulated by screwing the pointed pin into or out of the entrance of the discharge stem, and thus varying the orifice through which the oil enters the stem after being thrown upward, as above described. This cup is one of the Lunkenheimer line. Fig. 5 is the "Essex" cup, in which exactly the same principle and method of adjustment are employed. Figs. 6 and 7 differ from the two cups last mentioned in that they are provided with pin valves which normally close the delivery outlets of the cups, but are thrown upward by the action of the crank-pin along with the oil, and thus allow oil to enter the discharge canal and pass to the crank-pin periodically. The rate of feeding is regulated in the cup shown by Fig. 6 by adjusting the limiting pin immediately above the head of the valve-pin and thus varying the distance to which the valve is thrown from its seat. Feeding is regulated in the cup of Fig. 7 by varying the position of the nut on the valve-pin; the pin is hollow, and oil gains entrance to it through small holes drilled in the side in such a position that more or less of them may be covered by the nut, according to the position of the latter. These two cups, Figs. 6 and 7, are also Lunkenheimer products.

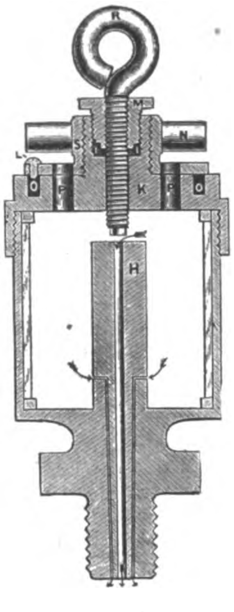


FIG. 8.

Fig. 8 is a cross-section of a double-feed automatic crank-pin oiler made by the Penberthy Injector Company, Detroit, Mich. In this cup a central plug *H* serves as a valve, and has a hole through the center through which oil is delivered at one point in the stroke. When the valve plug is thrown upward against the regulating screw *R* oil is admitted to the central hole in the stem of the cup, as indicated by the two arrows near the bottom of the chamber. The valve-stem is a loose fit in the hole, so that the oil is enabled to trickle down between the valve and the walls of the hole in the cup-stem.

AN INTERCOMMUNICATING TELEPHONE SYSTEM FOR PRIVATE HOUSES.

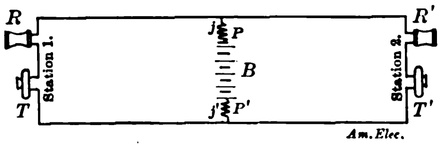
BY A. DALLAM O'BRIEN.

In an interior telephone system suitable for private houses the number of stations is naturally limited, and the necessity for providing means whereby more than two stations in the system can be in use at any given time, is rarely great enough to warrant consideration.

These two facts render applicable to this class of service a type of system that is at the same time simple and efficient, easily installed and easily maintained. This typical system, with various modifications, is used by the great majority of the manufacturers of intercommunicating telephone apparatus, but the writer is not aware of any particular system where the elementary form is used.

The type of system here presented as thoroughly fitted for interior private house systems, is one in which the battery which furnishes current both for signaling and talking purposes, is bridged across a pair of leads common to every station on the system, the arrangement being strictly analogous to a generator and incandescent lamps wired in parallel.

Before going into the actual wiring of the system it is best to analyze a case where two instruments are connected in parallel with a battery, and see just what action takes place when conversation is carried on between the two instruments.



Am. Elec.

FIG. I.—TELEPHONE CONNECTIONS.

Referring to Fig. 1 the arrangement of the connections will be made clear. *T* and *T'* represent the transmitters, and *R* and *R'* the receivers; *B* represents the battery, and *P* and *P'* represent resistance coils cut into the circuit one on either side of the battery. Let "S" represent the resistance of the transmitter and receiver, connected in series at station No. 1, this resistance being the same for the instrument at station No. 2, and let "M" represent the resistance of each of the two coils *P* and *P'*.

Now consider that a person at station 1 talks into the transmitter and follow the action that takes place and note the effect on the receiver at station 2. The vibrations of the transmitter diaphragm at station 1 cause changes in the resistance of the transmitter at that station and these cause changes in the value of the current flowing in the branch of the circuit in which the transmitter *T'* is located. The changes in the value of the current flowing through the circuit cause variations in the difference of potential between the terminals, *j* and *j'* of the resistance coils, and as these terminals are really acting as bus-bars for the two instruments in question a change of potential at *j* and *j'* causes changes in the current through every circuit connected to them. Thus, variations in the resistance of the transmitter at station 1 will cause changes in the current flowing through the receiver at station 2, by varying the difference of potential between the bus-bar points to which station 2 is connected.

The value in ohms to be given to the resistance coils *P* and *P'* will depend very largely upon the voltage of the battery used, but in any event each resistance must be such that the value of the fraction

$$\frac{R_i}{R_i + R_c}$$

shall not remain constant as the value of R_i is varied.

In this fraction R_i equals the combined resistance of all instruments connected in parallel with the battery, and R_c is equal to the combined resistance of the coils *P* and *P'*.

It is evident from this expression that the resistance of the coils *P'* and *P* can be made anything, so long as they are not given a value that is infinitely small. Practically, however, it will readily be seen that the difference of potential at the terminals of the coils will depend directly upon their resistance, and that the greater the difference of potential that is caused by changes in the flow of current through the circuit, the greater will be the effect upon the receiving instrument. The difference of potential between these terminals is, of course, caused by the *IR* drop in the circuit and varies with *I* and *R*.

The addition of other stations bridged across the line does not change the principle of the operation and there is no theoretical reason why the number of stations should be limited. Practically, however, where the number of stations connected in a given system, rises above, say, ten or twelve, the liability of two stations desiring connections at the same time becomes so great as to necessitate some means of enabling this result to be accomplished, and of course it can readily be seen that the elementary system outlined herein fails to provide for this.

For private houses, however, where the number of stations does not exceed eight or ten, this system fulfills all the necessary requirements.

It is necessary to provide some means at each station that will enable it to signal any other station, and Fig. 2 shows how this can be done, using the same battery that is used for talking purposes, with a vibrating bell and push buttons at each station that it is designed to signal. Referring to the diagram, the transmitter and receiver at each station are indicated by the letters *T* and *R*, and the hook switch on which the receiver hangs when not in use is indicated by the letter *H*. The vibrating bells are marked with the numbers of the respective stations. The push-buttons are indicated by the springs and contact points near the bottom of the diagram, and are numbered according to the stations that they signal respectively. As the diagram shows, the levers of all of the hook switches are connected to the common battery wire, *a*, and the transmitters are all connected to the other common battery wire *b*.

The vibrating bell should be a rather low resistance bell, say, of about 20 ohms, and mounted in any convenient place, preferably near the telephone in order to save wiring.

The push buttons necessary for signaling purposes may readily be mounted in one strip, which is much preferable to the use of separate buttons. The necessary wiring consists of the two common line wires, *a* and *b*, and one wire for each station; that is, one wire must be led from the bell at each station to pass through every other station; hence the number of wires passing each station can be figured by adding to the pair of common battery leads a number equal to the number of stations on the line.

In order that the work of connecting up may be facilitated it is advisable to choose a distinctive color for the insulation on each wire and have it retain that color throughout the entire system; the task of picking out any particular wire being thus rendered a very easy one. No. 18 wire (B. & S.) will be large enough for a small interior system.

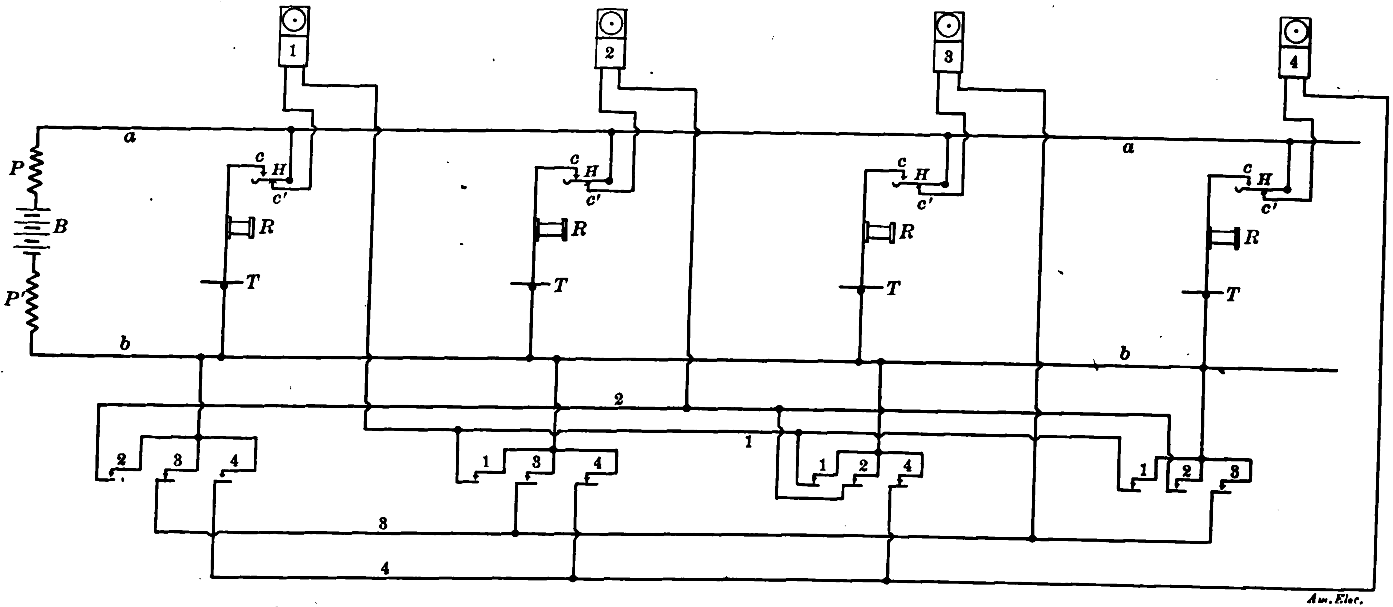


FIG. 2.—CENTRAL ENERGY INTERCOMMUNICATING TELEPHONE SYSTEM FOR PRIVATE HOUSES.

In the arrangement shown in Fig. 2 it will be seen that when the instrument at any station is in use, the bell is thrown entirely out of the circuit, one terminal being open at the hook switch and the other at the push buttons.

It is not, however, customary to build small instruments of this kind with a lower contact on the hook switch, and in case an instrument cannot be procured which has this lower contact, the bell may be connected into the circuit by connecting one terminal direct to the switch itself, the other terminal being connected as shown, to the push buttons. This arrangement leaves the bell permanently connected to one side of the line, but in a system of this kind this fact will usually not cause any inconvenience.

The number of cells of battery required will vary with the kind of transmitter used, but a battery of six cells of either the Leclanché or the Fuller type will be found sufficient for any case that may arise, and in the majority of cases four cells will be quite sufficient. The cells should, of course, be connected in series so as to give the combined voltage of all the cells used.

The batteries should be located in a place where they can be easily reached for making renewals, and should be placed so that the length of wire required to reach the various stations will be a minimum. In some cases it may be found more convenient to locate the batteries centrally, and to have the lines to the various stations radiate from the battery terminals; in other cases it may be more desirable to run one pair of line wires from the battery through each station in turn. The arrangement in any particular case will, of course, be governed by local conditions.

The resistance coils should be located at the battery, and the battery terminals connected directly to the terminals of the coils, the line terminals being connected to the other terminals of the coils. The resistance of these coils for cases where the battery does not exceed ten volts, should be about five ohms.

A system of this kind will be found very easy to install and very easily maintained, and if the work is well done in the first instance, little trouble will arise later.

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An Electrical Testing Laboratory—The Lamp Testing Bureau, which has for the past seven years been operated as a department of the Association of Edison Illuminating Companies, has been resolved into an entirely separate organization, and incorporated, for the purpose of doing electrical testing of all kinds and for any one desiring such work. The Bureau has a well equipped laboratory at 14 Jay street, New York, containing modern facilities for testing arc and incandescent lamps, measuring instruments, transformers, etc. It makes a specialty of calibrating instruments against authoritative standards, provides secondary standards of photometric and electrical units and is prepared to make performance tests of meters and candle-hour tests of lamps. In short, the object is to provide consulting engineers and central station men with facilities for making every scientific electrical test of practical importance to the industry, except those requiring large power supply, such as full-load tests of big generators.

Lessons in Practical Electricity

STANDARD ELECTRIC MOTOR CONNECTIONS.

Motors for ordinary service are provided usually with a simple shunt field winding, but sometimes with a compound winding; the shunt-wound machine is considered the standard in American practice. When the armature is at rest, there is, of course, only the resistance of its winding and connections to oppose any flow of current through it, and this resistance is always made as low as possible in order to secure good efficiency. The rush of current through it, if connected directly to the circuit while at standstill, would be many times greater than the full-load running current; therefore, when the motor is to be connected to the supply circuit for operation, it is customary to put extra resistance in series with the armature in order that the initial rush of current may not be so excessive as to damage the winding.

The connections at the instant of starting are as shown in Fig. 1, in which all of the elements are named. The "starting resistance" is so chosen that the current that will pass through the armature before it can get in motion will not be sufficient to damage it. As soon as the first rush of current takes place, the armature starts to turn and immediately generates a counter e. m. f. which cuts down the current; some of the starting resistance is then cut out of circuit, allowing the armature to increase its speed, and consequently its counter e. m. f. This process is repeated until all the starting resistance has been cut out, leaving the brushes connected directly to the supply circuit, like the field winding.

In practice, it is not usually necessary in cutting out the starting resistance to wait until the armature has ceased to increase its speed before cutting out more resistance. The resistance conductor consists of coils of wire connected to contact-buttons over which the end of a pivoted lever travels, as indicated in Fig. 2, and it is customary to move the lever slowly but continuously through its arc of travel over the buttons until all the resistance is out of circuit. The arrangement described is a "motor-starting rheostat," but is commonly termed a "starting box." In order to shut down the motor, the main switch must be opened first, and then the lever moved back to the starting position.

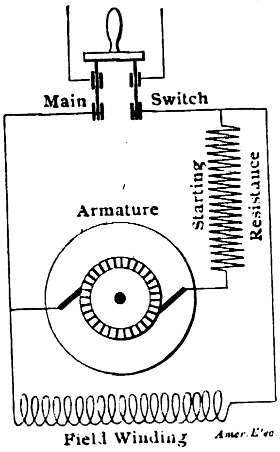

FIG. 1.

In all modern motor-starting rheostats, the lever is held in the running position either by a magnet or by a latch which is under magnetic control. The magnet coil is connected in series with the field winding, so that when the main switch is opened the magnet is de-energized and, therefore, releases the starting lever. A spring is permanently attached to the lever, and serves to throw it back to the starting position automatically as soon as the magnet releases it. Fig. 3 shows the connections of such a starting box, the lever-retaining magnet being shown at *m*, and the lever being provided with an iron armature, *a*, which is brought into contact with the magnet poles when the lever is moved over to the running position. The object in providing this arrangement is to insure that the lever will be returned to the "off" position whenever the current supply to the motor is cut off, either intentionally or accidentally, so that when it is desired to start up again there will be no liability to having the motor thrown into circuit while all of the starting resistance is cut out by the lever.

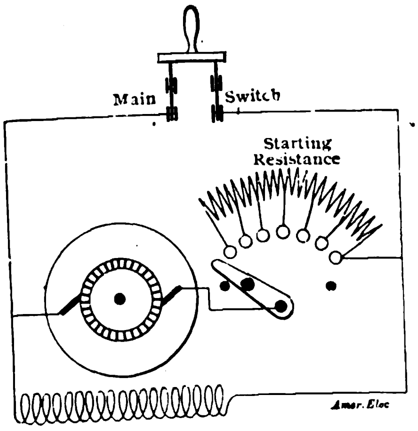

FIG. 2.

The reason the magnet is inserted in the field winding circuit is that it may cause the lever to be thrown to the "off" position in the event that the field circuit should be accidentally broken. If this should occur with an arrangement like that shown in Fig. 2 while the lever is at the right-hand end of its travel, thus cutting all the resistance out of the armature circuit, an enormous current would flow through the armature, as the field magnet would be demagnetized and thus stop the generation of the counter e. m. f. by the armature. With the arrangement shown in Fig. 3, the opening of the field circuit demagnetizes also the retaining magnet *m*, and the lever opens the armature circuit.

When the main switch is opened in order to shut down the motor and the lever is thrown back by the spring, the field-winding circuit is opened, and the sudden cessation of magnetism in the magnet core induces an instantaneous e. m. f. in the winding, which is very much higher than the e. m. f. applied to it in service. The self-induced e. m. f. is likely to puncture the insulation of the winding, and in order to avoid this liability the arrangement indicated in Fig. 4 has been used. This serves to connect the field winding to the armature immediately after the lever has disconnected the armature from the wire leading to the main switch, and while the armature is still turning over; this connection is shown by the diagram (the main switch is shown closed, however, all of the diagrams being intended to represent the equipment after the switch has been closed for starting, preparatory to cutting out the starting resistance by means of the rheostat). The result of this connection is that the counter e m. f. of the armature supplies a small current to the field winding, which prevents the rapid decline of magnetic excitation that induces the dangerous e. m. f. under the conditions just described.

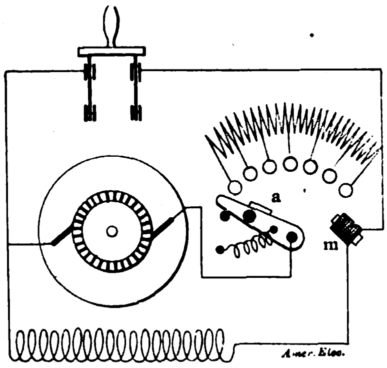

FIG. 3.

Even if the armature has come to a standstill before the lever flies back, the fact that the field winding is not open-circuited is a protection, because a close-circuited coil on a magnet core tends to "kill" any self-inductive effect by providing a path for the induced current, the direction of which is such that it tends to *maintain* the original magnetization of the magnet core. In other words, the self-induced current is allowed to "choke" out the e. m. f. that causes it to flow. The method shown by Fig. 4, however, is not so effective as the method of connection shown in Fig. 5, which is commonly used by American builders. Here the field winding is always connected to the brushes through the starting resistance, and when all the resistance has been cut out of the armature circuit, the field winding receives current from the supply circuit through the resistance. The exciting current is so small, however, that the "drop" due to its passing through the resistance is never serious.

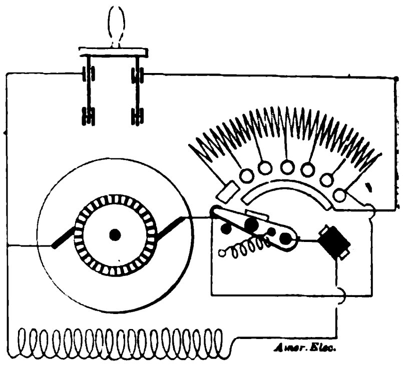

FIG. 4.

For example, an ordinary 110-volt motor requiring an armature current of 40 amperes at full load will require not over 2 amperes in the field circuit; the starting resistance will not be more than 3 ohms, so that the drop in voltage in the field circuit will be 6 volts when the motor is running. The result of this is that the field magnet is somewhat stronger when the motor is first thrown on the line than after the resistance has been cut out and the armature has attained full speed. Consequently, the motor has its greatest torque at starting, which is almost always an advantage. The figures cited, however, are unusually high for even so small a machine as 5 horse-power—the size taken for the example; a drop of 3 to 5 volts in the field circuit voltage is more common.

It will be noticed that two of the contact buttons on the rheostat in Fig. 5 are without connections. The object of this arrangement is to reduce as far as possible the sparking between the lever and the button *1* when contact between the two is broken. Whatever sparking there may be is transferred from the lever to the button *o*, and when the lever passes out of contact with this button if any arc should remain between the buttons *o* and *1* it is destroyed by the addition of the air resistance between the button *o* and the one on which the lever is shown resting in the diagram.

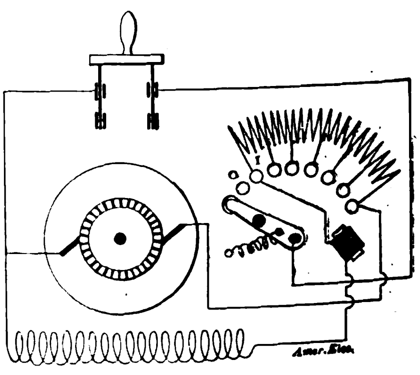

FIG. 5.

When compound-wound motors are used for ordinary service, the function of the series field winding generally is to supply an extra strong field during the process of starting the machine up, so as to obtain an extra torque then. In most cases, the arrangement of the starting box is such that the series winding is cut out of circuit after the machine has been brought up to speed. The connections of such a starting box are shown by Fig. 6, where the series winding is indicated by the coil *S*, and is connected between the last two buttons of the rheostat. The result of this arrangement obviously is that the series winding remains in circuit until all of the starting resistance has been cut out, when the movement of the lever from the seventh to the eighth button cuts out the series winding.

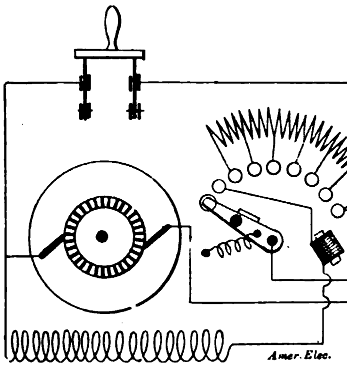

FIG. 6.

With the lever in the full running position, the shunt winding receives its current, as in the case of Fig. 5, through the starting resistance. The exciting current also passes through the series winding, *S*, but passes through it backwards, so that this winding is magnetically opposed to the shunt winding. The ratio, however, between the number of turns in the shunt winding and the number in the series winding is so great that the demagnetizing action of the series winding is practically negligible. If it were appreciable, the effect would be to reduce the variation in the speed of the armature by weakening the field as the load increases and strengthening it as the load decreases; as explained previously, strengthening the field causes the armature speed to drop, and weakening it has the reverse effect so long as there is sufficient field to give the torque required by the load; this action of the series winding in the case under discussion would tend to compensate for the variation in speed due to the variation in voltage drop in the armature when the load varies.

In some cases the series winding is left permanently in circuit, but this is not usually advisable, for the reason that it entails excessive irregularity in the speed of the machine. With a series winding constantly in circuit the strength of the field is greater with a heavy load than with a light load; consequently the drop in speed will be greater as the load increases than it would be if the series winding were cut out.

◆◆◆

Switchboard Polish—For polishing white marble switchboards, the following dressing may be applied with white flannel: 10 parts white wax, 2 parts Japan gold size and 88 parts turpentine.

Letters on Practical Subjects

A Handy Appliance for Assemblers.

To the Editor, American Electrician:—

Perhaps some of your readers will be interested in the little shop kink which is described in the following and the accompanying sketch: The little tray shown in Fig. 1 is for the purpose of holding screws in position to be picked up by the screw-driver shown in Fig. 2. For the assembling bench I have found this tray and screw-driver to be of the greatest value.

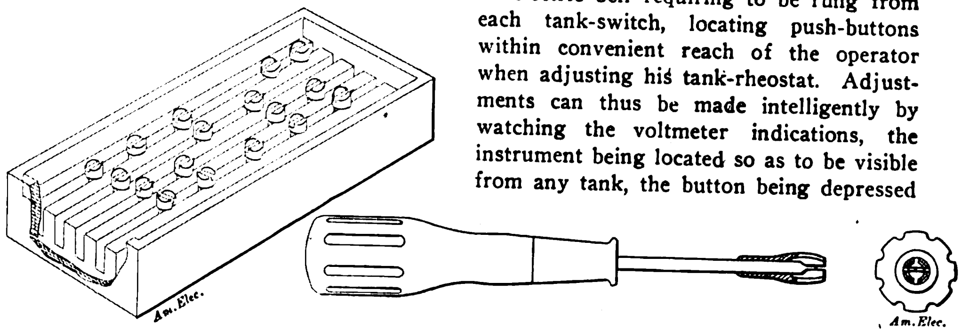

FIG. 1.—TRAY AND SCREW-DRIVER.—FIG. 2.

If a box of screws be poured into the tray, and the latter shaken two or three times, every screw will fall into the grooves, head upward. If small brads are driven in the tops of the ribs (not shown in cut) the screws will fall into the grooves more readily. The screw-driver or "pick up," as I call it, is then pressed over a screw, the spring sides being stiff enough to hold the screw so it can be entered and screwed until pressure comes on; then the driver revolves part of a half turn, until the positive driving blade slips into the slot of the screw-head, and a firm pressure can then be applied.

I have used this outfit for some time assembling brush-holders, and have found it a great time saver.

J. S. BORDEN.

Louisville, Ky.

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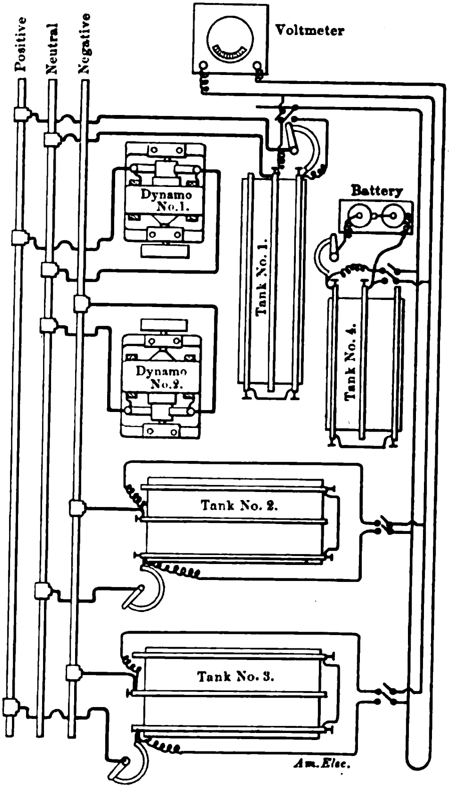
Voltmeter Connections in Electroplating Service.

To the Editor, American Electrician:—

Some time ago an article appeared in the AMERICAN ELECTRICIAN explaining some of the uses and advantages of voltmeters in plating operations and illustrated a method of connecting them to tanks that has been adopted to some extent since. Several voltmeter manufacturers have put on the market instruments arranged for this purpose, which are mounted on a board provided with numbered contract buttons to be connected to correspondingly numbered tanks, and having a pivoted switch lever arranged to swing into contact with any one of the buttons and connect it to the voltmeter. This arrangement is ideal where it is desired to keep watch on all tanks from one point, but in most cases it is objectionable in that it obliges the operator to visit the voltmeter board each time he is about to charge a tank. This takes up so much time and is so inconvenient that in busy plants, where the voltmeter should be the most useful, it is apt to be neglected, and eventually condemned as useless, the operators finding the old guesswork methods more convenient, if less reliable.

To overcome this condition in a large plating plant, I adopted the simple expedient of wiring a voltmeter in connection with all the tanks, exactly as though it were an electric bell requiring to be rung from each tank-switch, locating push-buttons within convenient reach of the operator when adjusting his tank-rheostat. Adjustments can thus be made intelligently by watching the voltmeter indications, the instrument being located so as to be visible from any tank, the button being depressed until the proper voltage is indicated, when the push-button is released, of course, leaving the voltmeter available for use in connection with any other tank.

This method proved satisfactory until enlargements and improvements in the plant required another generator, and the two were connected by the three-wire system. To meet the new conditions, the method illustrated in the accompanying diagram was adopted, which allows one voltmeter to be used for the several sources of cur-



ELECTROPLATING CONNECTIONS.

rent and all the tanks. It will be noticed that tank No. 1 is in circuit with dynamo No. 1, tank No. 2 with dynamo No. 2, tank No. 3 in series with both dynamos, and tank No. 4 is supplied from a battery. The voltmeter was wired as illustrated, because it was found that by direct wiring there was a difference of reading between tanks near the instrument, and those a distance away; this arrangement served to equalize the voltmeter resistance from all points, but it would be unnecessary with most instruments. A pair of wires leading from the voltmeter are run around the plant and as near to all tanks as convenient, from which branch wires extend connecting with tank terminals; both wires in all these branches are cut and double-pole switches inserted, and these are preferably mounted on or near the tank-rheostat. The switches should be such as to insure good connections, and the instruments should have as long a scale as possible to enable reading at long range.

Any direct-current voltmeter of the proper range can be used, and one of the very cheapest type was used for several months successfully, it being displaced later by a larger and dead-beat instrument, the advantages being visibility from a greater distance, and quicker reading.

W. L. Churchill.

Chicago, Ill.

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Arc Lamp and Spark Coil Connections.

To the Editor, American Electrician:—

With reference to the question of determining the correctness of arc-lamp connections discussed in recent issues of the American Electrician, I wish to mention a method that I have used for some time which enables one to make this determination by simply glancing at the lamp from the floor. When the purple rays from the arc are thrown to the top of the globe, the lamp is connected properly; conversely, if there is a purple tinge near the bottom of the globe, the connections should be reversed.

In answer to the question of "C. W. R.," on page 498 of the October number, it was stated that it made no difference which way a spark coil was connected to the battery for gas engine ignition. I should like to state that it makes a great deal of difference, so far as the igniter is concerned. I have found in practice that the polarity of the circuit with relation to the igniter should be changed every day by means of a suitable switch, for the reason that if the battery is left permanently connected in one direction the igniter points will burn away unequally, and as the igniter parts are rather expensive, it pays to reduce the wear and tear on them by changing the polarity of the battery, as suggested.

George Frank.

New York City.

[Mr. Frank's plan of reversing the polarity of the battery is not affected in the least by the question of whether the spark coil should be connected in the positive or the negative lead of the battery, which was the question asked by "C. W. R." It is not the relation between the polarity of the battery and the spark coil which causes the unequal wasting away of the igniter points, but the relation between the battery polarity and the igniter points themselves.—Editor.]

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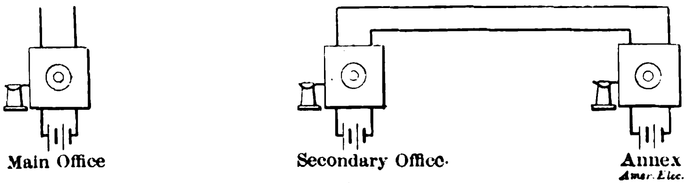
More Telephone Connection Problems.

To the Editor, American Electrician:—

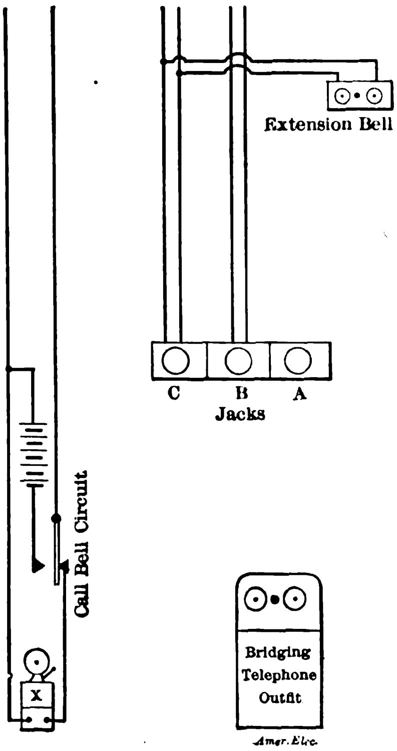
I submit herewith another telephone circuit problem with which I have recently been confronted, thinking it might be of interest to your readers. A factory building was equipped with a calling system of push-buttons and bells formerly used in connection with speaking tubes, the tubes having been displaced by an open-circuit telephone system in which the instruments are normally cut out from the line by the hook switch. An annex was added and a two-instrument equipment provided therein to furnish communication between the annex and a secondary office. The owner wished the equipment to be arranged so that he could call the annex from his main office and be able to switch the annex circuit on to the regular factory circuit for talking, but did not care to have the connections such that the annex and second office stations could call him up. It was not convenient to run more wires between the annex and the second office, the connections of which are indicated in the accompanying diagram. In working out a solution of the problem it is of course necessary to bear in mind that the calling system at the main office was entirely distinct from the talking system, whereas the equipment of the secondary office and the annex was of the ordinary kind, combining both calling and talking facilities.

Arthur T. Chase.

Haverhill, Mass.



MR. CHASE'S PROBLEM.



MR. FISK'S PROBLEM.

To the Editor, American Electrician:—

The following problem in telephone connections may be of interest to readers of the American Electrician. While some alterations were being made at one of our signal towers, orders were received to connect this to another one so that telephone communication could be had. There was already a bell circuit between the two towers, and permission was given to utilize this circuit for the telephone service, with the requirement that leaving the telephone set connected to the circuit should not prevent the use of the latter for the ordinary bell signaling service. The accompanying diagram indicates the tower end of the bell circuit, and shows also two metallic telephone circuits running into the tower from other points and terminating at jacks, *B* and *C*. The bridging telephone set was provided with a two-wire plug, by means of which it could be connected to either one of the three circuits through one of the jacks. The problem is to connect the jack *A* with the call-bell circuit so as to fulfill the requirement as to non-interruption of that circuit in the event of the plug being carelessly left in the jack, and also to provide some means whereby the circuit *B* can call up the tower. The circuit *C* is provided with an extension bell, as shown. It must be kept in mind that the call-bell circuit is of the ordinary battery type, whereas the signaling apparatus on the telephone and the other two circuits is of the magneto type. No additional switches to be used. No provision is necessary for cross-signaling between the various circuits.

Edwin R. Fisk.

Springfield, Mass.

To the Editor, American Electrician:—

We have from a certain toll station a grounded line running east and a grounded line running west, each belonging to different companies. There is a great deal of switching done between the two lines, and it is desired to mount a desk telephone set with suitable switches (not jacks) on a desk in order to do this switching quickly and conveniently. A booth telephone is to be located in another room for the convenience of the public. Connections must be so arranged that when a party is using the booth telephone east, the operator at the desk set may talk west, and *vice versa*. When the lines are connected through, the desk set and one set of bells must be left in circuit. Bridging bells of 1,000 ohms are used and only two grounds are allowed at the station; when the lines are connected through, one of these grounds and bells must be cut out. Will some one please show diagrammatically how this can be accomplished? **Jno. A. Diffey.**

Cotton Plant, Ark.

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Three-Phase Transformer Operation.

To the Editor, American Electrician:—

Referring to the peculiar incident in three-phase transformer operation cited in Mr. B. F. Pearson's letter, which appeared in the August number of the American Electrician, I beg to submit the following explanation. If two sets of transformers are connected in star with grounded neutral points, as shown in Fig. 1, it is well known that any unbalancing of either set will cause a current to flow between the neutral points through the ground. This unbalancing may be produced either by carrying a heavier load on one side of the Y than on the other sides, or by cutting out a transformer entirely. In the case experienced by Mr. Pearson, six sets of transformers had their primaries connected Y-fashion across the main line, with their neutral points connected to the ground, as shown in Fig. 2. The defective transformer, which was cut out, is indicated by *N*. Cutting out this transformer tended to produce the unbalancing effect upon the other five transformer sets for the reason that they all had a common connection to the ground and acted together as one transformer. It is obvious, however that those transformers closest to the unbalanced set (No. 4) will receive the largest ground current. This action is similar to that when a number of different resistances are put in parallel; those of lowest resistance will naturally take the greatest current.

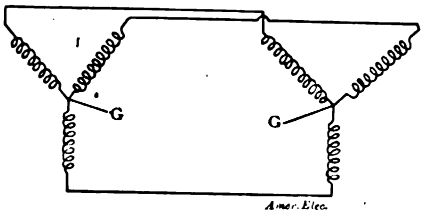

FIG. 1.—TRANSFORMER CONNECTIONS.

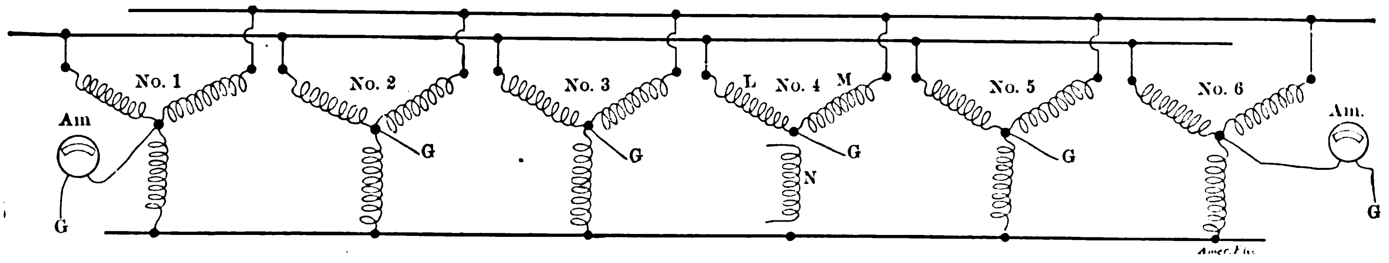

FIG. 2.—CONNECTIONS OF SIX SETS OF TRANSFORMERS WITH GROUNDED NEUTRALS; ONE SET CRIPPLED.

From the foregoing it can be seen that transformers Nos. 2, 3 and 5 received nearly all of the current through the ground from transformer No. 4, and since each of these stations are about twenty miles apart, transformers Nos. 1 and 6 received but a small portion of this current. This probably was too small to produce a deflection in the ammeters on the ends of the line. Since the normal potential had been maintained across the two transformers, *L* and *M*, the induction in the secondaries was normal. The voltage across phase *N*, however (Fig. 3), would be a trifle less than normal, owing to the resistance and inductive drops of the two transformers, *L*, *M*, through which the current of this phase passed.

P. C. Butte.

San Francisco, Cal.

Electrical Catechism

710. Are there any other means of detecting silver plating?

Yes. The custom house officers in Germany are directed by law to use the following process for the determination of genuine silver plating. A portion of the article is washed with ether or alcohol and a 1 to 2 per cent. solution of crystallized bisulphite of soda is applied to the spot thus cleansed. The solution is prepared by boiling 1.05 ounces of sodium sulphite and 2.36 drachms of flowers of sulphur with 0.88 ounce of water until the sulphur is dissolved. The mixture is then diluted until one quart of the fluid is obtained. A drop of the solution is allowed to remain on the article about ten minutes, and is then rinsed off with water. Upon silver articles a full round steel-gray spot is produced. Other white metals and alloys, with the exception of amalgamated copper, do not show this phenomenon. Amalgamated copper is more quickly colored and acquires a more dead black color than silver.

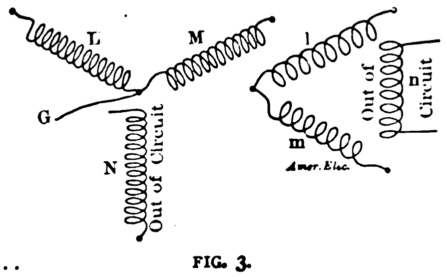

FIG. 3.

711. How may gold be stripped from gilded articles?

Gilded articles of iron and steel are best stripped by treating them as anodes in a solution of from 2 to 2¾ ounces of 98 per cent. potassium cyanide in one quart of water and suspending a copper plate greased with oil or tallow as a cathode. Gilded silverware is readily stripped by heating it to ignition and then immersing in dilute sulphuric acid, whereby the layer of gold cracks off, the heating and subsequent immersion in dilute sulphuric acid being continued until all of the gold is removed. Before heating and immersing in dilute sulphuric acid, the articles may first be provided with a coating of paste composed of sal ammoniac, flowers of sulphur, borax, and nitrate of potash, which is allowed to dry. On the bottom of the vessel containing the dilute sulphuric acid the gold will be found in laminae and scales, which are boiled in pure sulphuric acid, washed and finally dissolved in *aqua regia* and made into chloride of gold. Articles of silver, copper or German silver which will not bear heating are immersed in a mixture of one pound of fuming sulphuric acid, 2.64 ounces of concentrated hydrochloric acid, and 1.3 ounces of nitric acid. The articles are dipped in the warm acid mixture and the progressive action is watched by frequently removing the articles from it. It is important to have the articles to be treated perfectly dry before they are immersed in the acid mixture, and care must be taken to preserve the latter from dilution with water in order to prevent the acids from acting on the basis-metal.

712. How may gold plating be determined?

Objects apparently gilded may be rubbed upon the touchstone and the streak obtained treated with pure nitric acid of 1.30 to 1.35 specific gravity. The metal contained in the streak thereby dissolves and as far as it is not gold disappears, while the gold remains behind. The touchstone should be thoroughly cleaned before each operation, and the streak should be made not with an edge or a corner of the object to be tested, but with a broader surface. If no gold remains upon the stone, but there is nevertheless a suspicion of the article being slightly gilded, it is first washed with alcohol and then with ether and dried upon blotting paper. Pour over it in a test tube, previously cleansed with alcohol or ether, from .084 to 5.64 drachms of nitric acid, depending on the size of the article, free from chlorine and having a specific gravity of 1.3. The article will be immediately dissolved, and if it has been gilded ever so slightly perceptible gold spangles will remain upon the bottom of the tube. The fineness of gold may also be approximately estimated by means of the touchstone. From the rapidity of the action and the intensity of the green color produced, as compared with streaks made by alloys of known composition, it is possible to judge of the proportion of inferior metal which is present.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

Was the excitation-density curve published on page 91 of the February number taken from solid wrought iron or sheet, and what was the commercial quality of the iron? D. E. C.

The curve is an average of several curves taken from the best obtainable grades of solid wrought iron which had been annealed before it was tested.

Does it matter in which of the main leads of a compound-wound direct-current dynamo the ammeter is connected? If so, why? J. H. B.

Yes. If the ammeters of two machines are connected in the leads from the series windings, as in Fig. 1, the effect is precisely the same as though the connections were made as shown in Fig. 2. From the latter diagram it will be plain that each ammeter merely shows how the current divides between the two series windings, and does not necessarily indicate the current passing through the individual armatures. For this reason the ammeter should be invariably connected in the lead from the free brush. The diagrams are, of course, purely elementary, the shunt coils, switches, and other details being omitted for clearness.

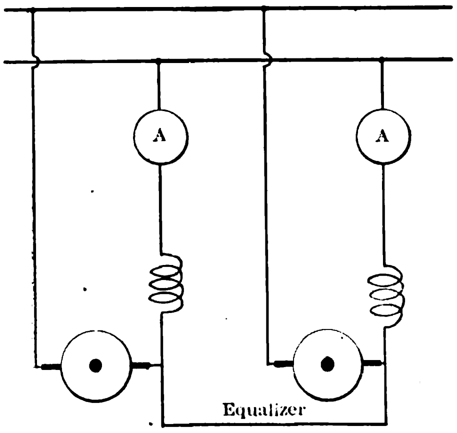

FIG. 1.

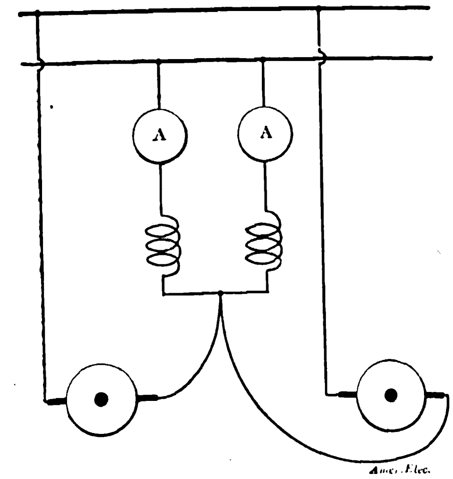

FIG. 2.

Can I operate twelve 50-volt 25-c.p. lamps and four 100-volt 50-c.p. lamps in series on a 1000-volt alternating-current primary circuit? J. M. G.

Yes; provided the lamps are all of the same economy. If the lamps of one voltage are of higher economy than those of the other voltage, either the more efficient lamps will be burned out or the others will not burn at full candle-power.

Please give data for an induction coil to give an 8-in. spark. H. B. B.

Make the core of No. 21 soft iron wire, using enough wires to give the core a diameter of 1¼ ins. The length should be 15 ins. Use two layers of No. 11 wire for the primary coil, winding it to within one inch of each end of the core. The secondary coil should consist of 9 lbs. of No. 36 wire wound to the same length as the primary coil.

Can the induction coil described in "Electrical Designs" be operated from a 110-volt direct-current circuit instead of a battery? (2) If so, what changes will be necessary in the construction of the coil? C. M. G.

Not unless a Wehnelt interrupter is available; the ordinary spring vibrator would be soon destroyed if used on a high-voltage circuit. (2) The primary coil should consist of No. 24 wire instead of No. 12, and should have fifteen times the number of turns specified in the book for the No. 12 wire.

Why is it that a marine engine of the beam type takes up a perceptibly increased speed a few moments after first being started, without any adjustments of cut-off or steam supply? (2) A shunt-wound motor having an armature drop of only 4 per cent. shows a drop in speed of about 11 per cent. between no-load and full-load with the potential maintained absolutely constant at the terminals of the machine; what causes the excess in drop beyond that due to the resistance of the armature circuit? G. W. M.

Because when the engine is at rest the vacuum falls somewhat, and as soon as it starts up the vacuum is improved, the air pump being operated from the walking beam. The brushes are probably set ahead of the proper commutating line, so that the armature wires midway between the field magnet poles exercise a strengthening effect on the field. If the machine runs continuously in one direction the brushes should be invariably given some backward lead. When this is done the coils midway between poles tend to demagnetize the poles and thereby keep the speed nearer constant.

What switching arrangement is necessary in order to allow any proportion or all of eight feeders to be connected to either phase of either one of two two-phase alternators, permitting a division of the load between the two machines, but making it impossible for the machines to be thrown in multiple? (2) How can two 8-in. gongs be connected in multiple so as to ring from a 220-volt direct-current circuit? A. B. C.

The arrangement indicated by the accompanying diagram (Fig. 2) will accomplish the results. As the diagram shows, the feeder switches do not connect the feeders directly to the generator bus-bars, but serve to connect them to one or the other of two sets of phase switches, which in turn direct the connections to either one of the two phases of each machine. Only four feeders are provided for here, but there is no limit to the number. (2) As shown by Fig. 1 herewith, in which *L* indicates two 32-c.p. 110-volt lamps; *R* is a resistance coil, and *S*, is a single-pole switch. It will not be practicable to use a push-button for ringing the bells, on account of the sparking when the circuit is opened. The resistance of the coil *R* should be such as to produce a difference of potential of 5 or 6 volts at its terminals when the switch is closed.

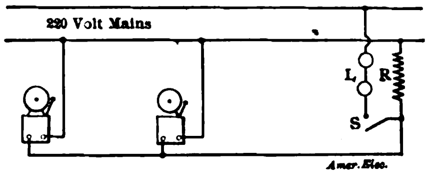

FIG. 1.—GONGS IN MULTIPLE.

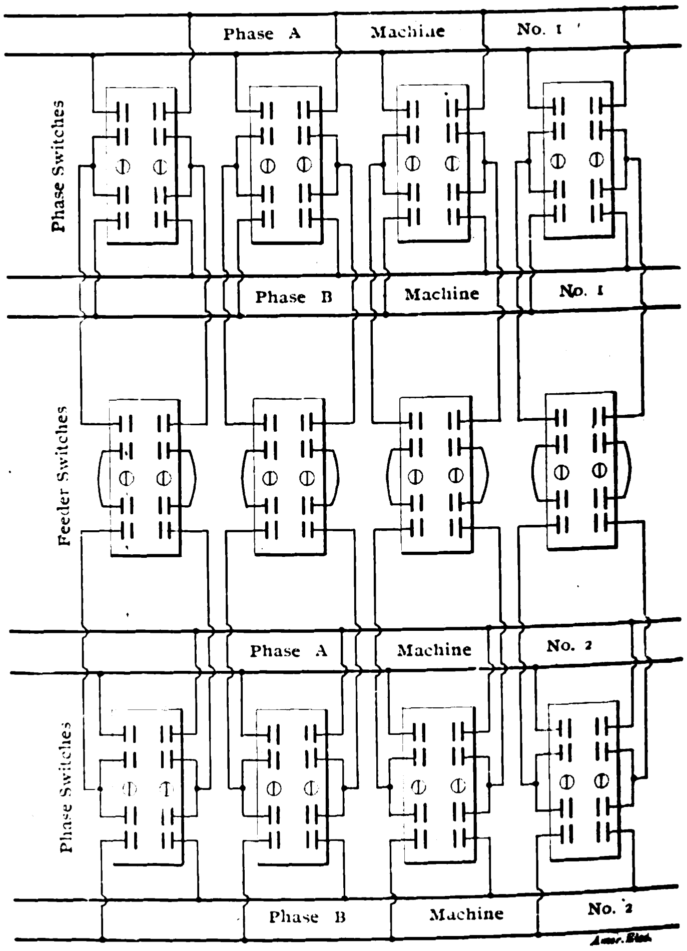

FIG. 2.—SWITCHING ARRANGEMENT.

THE KENNICOTT WATER SOFTENING APPARATUS.

BY C. R. JAMES.

The prevention of scale in boiler feed-water can be accomplished by the precipitation of the scale forming carbonates and sulphates of lime and magnesia out of the water before it is fed to the boilers. There are several chemicals which will accomplish the precipitation, the cheapest of which are quick lime and soda ash. The problem, therefore, resolves itself into treating large quantities of boiler feed-water with the correct proportions of lime water and soda solution, mixing thoroughly and settling the resulting precipitates. The continuous supervision of a skilled chemist is not feasible. The apparatus must preferably be automatic as regards its mixing and settling, and require no expert attendance after once being set up properly.

The Kennicott Water Softener Company, of Chicago, makes a softening plant in which all the details have been thoroughly worked out, and which is said to make it possible for small electric lighting companies to avail themselves of water purification and avoid the serious expense in repairs and fuel caused by boiler scale in many plants, especially through the middle West. A section through this purifying apparatus is shown by Fig. 1 herewith. The water to be purified is pumped to the small box called the hard water box, at the top of the apparatus. From there it flows to the mixing and settling tank at a rate depending on the height of water in the box. A float in the box is connected with float valves in two boxes lower down which regulate the rate of flow of the lime water and soda solutions. In falling from the hard water box the water turns an overshot wheel which drives a lime agitator and a scoop wheel. The scoop wheel dips up softened water from the purifying tank and throws it into a "soft-water box," from which it flows to the bottom of a lime water "saturator," which is the central cylinder with a conical bottom, shown in the cross section. The lime agitator revolves in the bottom of this saturator. As soft water is fed in at the bottom, saturated lime water overflows at the top of the saturator and there mixes with the water coming down from the "hard-water box" and the soda solution from another box.

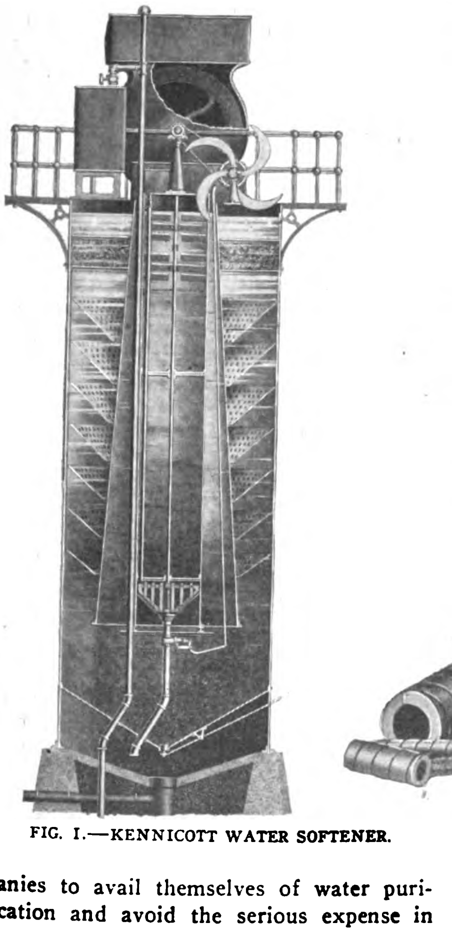
FIG. I.—KENNICOTT WATER SOFTENER.

The treated water then settles down through the conical chamber immediately surrounding the lime water saturator, constantly decreasing in velocity and allowing the precipitates to fall to the bottom whence they can be drawn off at the blow-off valve. The water then flows up through the outside chamber and what light precipitate has not already fallen is caught by the baffle plates and by a filter of excelsior at the top before passing out of an overflow at the top into a storage tank. The purifier illustrated is independent of the storage tank, but for railways and other plants requiring a compact equipment the storage tank is made to surround the purifier as illustrated.

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THE HYATT ROLLER BEARING.

In the adoption of the roller bearing, care should be taken to consider fully the advantages and disadvantages of the various designs, especially as regards the durability, efficiency and practicability of each. In fact, a thorough study of the mechanical principles involved will be of value, and is, of course, necessary if the designer or purchaser is to decide for himself what type of bearing is best suited to his particular needs.

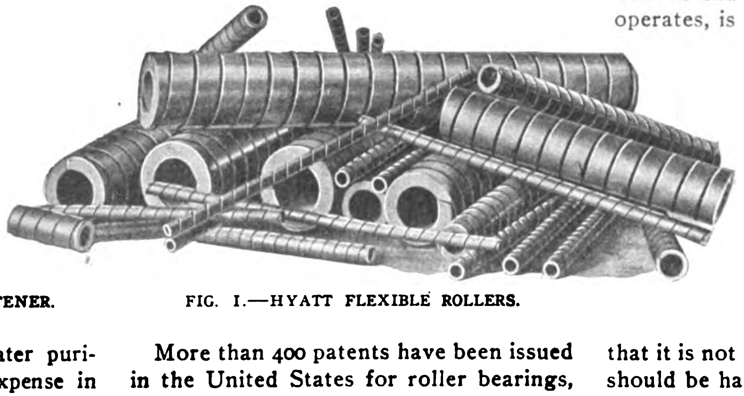


FIG. I.—HYATT FLEXIBLE ROLLERS.

More than 400 patents have been issued in the United States for roller bearings, and with a single exception, each one involves the use in some form of solid roller. Experience has demonstrated that such rollers must in general be hardened to secure even reasonable durability, and ground true in order to utilize the full bearing surface. This not only applies to the rollers themselves, but the surfaces upon which they operate, making it necessary to protect the axle or shaft with a hardened and ground steel sleeve and the box housing with a hardened case in which the rollers are contained. On account of the rigidity of a solid roller it is difficult to secure contact along its entire length, so that if it is applied on an ordinary steel shaft, or, in fact, any surface except one that has been hardened and ground, the life of both the roller and such surface will be so limited that such an arrangement is not permissible.

The Hyatt roller bearing was conceived with a view to overcoming this difficulty and providing a bearing of such simple construction that it could without difficulty be applied to machinery and apparatus of every kind and description, no matter what the conditions of speed and load. The distinctive feature of the bearing is the roller, which is made from a strip of special steel, wound into a coil or spring of uniform diameter. Fig. 1 shows a group of these spring rollers. By varying the diameter of the roller, as well as the thickness, width and character of the stock from which it is made, it is possible to so vary its nature as to enable it to operate under a wide range of conditions from heavy loads on one hand to high speeds on the other. The greatest advantage of a roller of this construction, of course, is its flexibility, enabling it to present at all times a bearing surface along its entire length. The result, it is claimed, is that the wear of the roller as well as that of the surfaces on which it operates, is diminished to such an extent that it is not necessary that these surfaces should be hardened and ground.

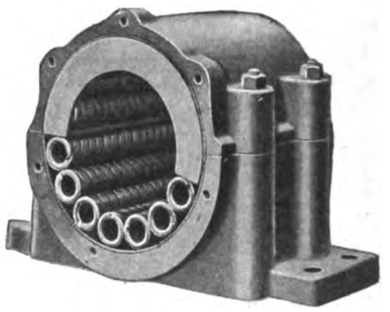


FIG. 2.—BUSHING FOR HEAVY DUTY.

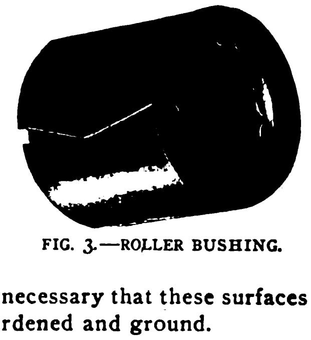


FIG. 3.—ROLLER BUSHING.

When steel axles are used, as is generally the case, no sleeves are required, thereby reducing the bearing to the simplest possible elements. The sleeves and linings provided for this roller, when either the shaft or the case in which it revolves is iron, are soft steel and can be made solid or split as desired, another distinct advantage, as in many instances the latter is preferable and in others absolutely essential.

It will also be seen from its construction that the roller essentially acts as an oil reservoir, while the spiral and roller together perform the function of an oil carrier, thereby ensuring perfect lubrication of all parts at all times, making it possible to operate the bearing for considerable intervals without attention. This type of roller can be successfully used, although, of course, with diminished life, in dusty and gritty places, as all foreign matter has a tendency to collect inside, and consequently the effect on the bearing itself is considerably reduced. The rollers are held in alignment by a yoke or cage, the design of which is varied as experience may dictate. Fig. 4 shows one form of this yoke or cage.

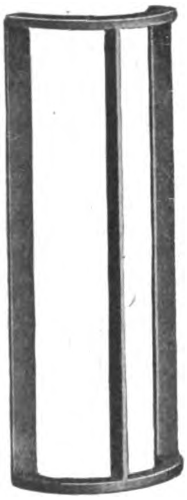


FIG. 4.—CAGE.

The diameter of the roller, as well as the cross-section of the stock from which it is made, will vary according to the speed of the bearing and the load to be carried. As the speed is increased the diameter of the roller should also be increased, and it should be made of lighter stock; as the load increases the stock used should be proportionately heavier. At what may be termed slow speeds, or less than 50 r.p.m., the safe working load may vary considerably with the diameter of the roller, the other dimensions of the bearing remaining the same. It is advisable to use as large a roller as is consistent with the axle or shaft, for the efficiency of the bearing increases with the diameter of the roller.In order that proper dimensions may be used, the makers of this bearing provide tables of dimensions for all customary speeds and loads, and also giving the approximate diameter of the necessary bushing to operate under such conditions. The safe working load is figured on a basis of projected area, for various diameters of roller, and is based on an average load of about 500 pounds per square inch.

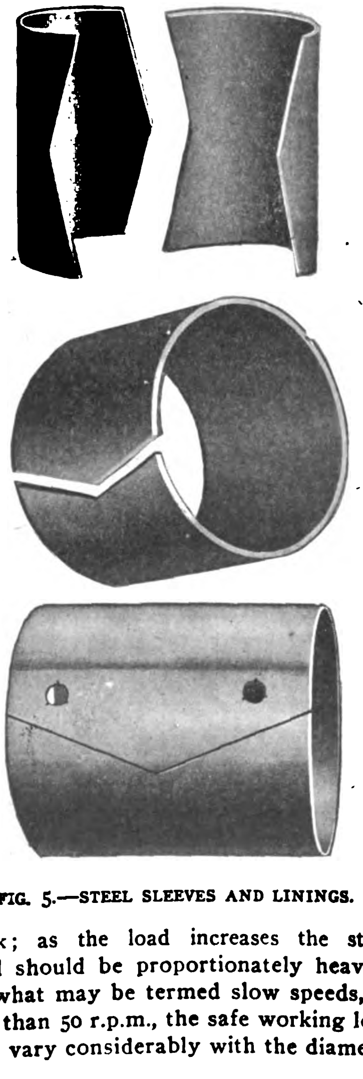


FIG. 5.—STEEL SLEEVES AND LININGS.

Cold rolled or turned steel shafting will operate satisfactorily in these bearings without any steel sleeves. In case iron axles are to be used, they must be protected by steel sleeves, and in calculating the load under such conditions, the outside diameter of the sleeve should be figured as the diameter of the bearing. It should be stated that the safe working conditions may, in some instances, be more severe than allowable according to the tables, and in many cases, smaller rollers are permissible.

The Hyatt roller bushing, as illustrated by Fig. 3, is the form of bearing supplied in cases where the box, wheel or housing, as the case may be, is a part of the frame of the machine itself, or where only the bearing proper is desired. For very heavy duty work, and where the box housing is desired, the form shown by Fig. 2 is furnished.

◆

ELECTROSTATIC GROUND DETECTOR.

The electrostatic ground detector recently placed on the market by the Fort Wayne Electric Works is a very simple instrument and possesses some features not found in other instruments. In principle also it differs somewhat from other ground detectors. In all types of electrostatic ground detectors the principle of the electrostatic voltmeter is employed, the deflecting torque being created by the attractive force between electrically charged surfaces. In most single-phase ground detectors the line terminals are connected to two stationary plates, or two sets of plates and the movable plate or vane is connected to earth. When no ground exists, the movable member is attracted equally by the two stationary parts connected to opposite sides of the line, but as soon as one side of the line is connected to earth, or grounded, the partial neutralization of the charges on the movable vane and the grounded line produces an unbalanced condition between the attractive forces of the two stationary plates and the movable vane and causes a deflection of the pointer attached to the vane toward the grounded side. The amount of the deflection indicates roughly the conductivity of the ground, a direct ground throwing the pointer to the limit of its motion in the direction of the grounded side, while leakage or a partial ground is indicated by a slight deflection.

In the Fort Wayne single-phase electrostatic ground detector the line terminals are connected to stationary members composed of sheet aluminum stamped and pressed into a shape not unlike a double rake with curved pointed teeth. The charge produced by the line potential is concentrated on these points according to a well-known law of electrostatics. The movable member consists of two similar sets of points carried on opposite ends of an arm mounted on a shaft set in jewel bearings. These points are free to move in or out between the double sets of stationary points. The moving parts are in no way connected to the circuit, but receive their charge from a set of points that are charged by another group directly connected to the earth. A delicate torsion spring connects the shaft to these stationary points and together with a light adjustable weight on the shaft maintains the pointer at zero position under normal conditions.

The mechanism of the instrument is rigidly mounted on and thoroughly insulated from a solid metal base, which is designed for mounting on switchboards. The cover is easily removed without disturbing the adjustment or connections which are all made from the back. The scale is of silvered brass, mounted in the top of the case as in other round switchboard instruments. The middle of the scale is the zero, or "no ground" position of the pointer. Fig. 1 shows it in this position.

The instrument is connected permanently in circuit through graphite sticks carried on hard rubber insulators mounted on a marble base designed for mounting on the back of the switchboard. The resistance of these graphite sticks is sufficient to protect the instrument and the circuit from accidental grounds or short circuits within the instrument itself.

This ground detector may be used on two-phase or three-phase circuits, two instruments being required in either case. For two-phase two-wire circuits, two ground detectors and two sets of three graphite resistances are employed; only one set of four resistances and two instruments are necessary for three-wire two-phase or three-phase circuits.

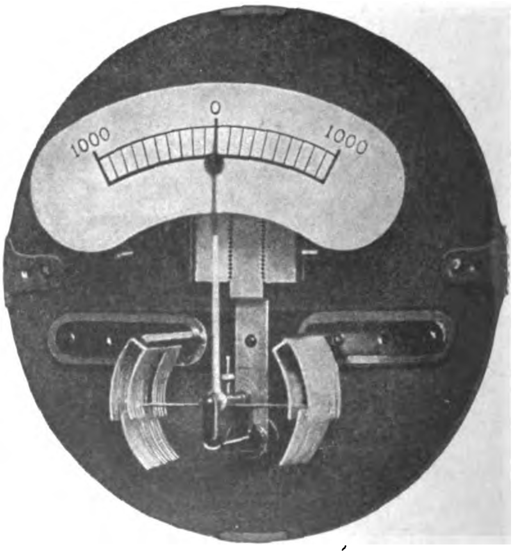


FIG. 1.—ELECTROSTATIC GROUND DETECTOR.

New Apparatus and Appliances

ELECTRIC HEATING AND COOKING APPARATUS.

An electric heating system, which has been developed in Europe, is being introduced in this country by the Prometheus Electric Company, of New York City. The company is now manufacturing a complete line of cooking utensils and heating apparatus, including chafing dishes, tea kettles, hot water boilers, coffee machines, hot water urns, plate warmers, broilers, stoves, laundry irons, laundry machines, pleating machines, curling irons, soldering irons, glue pots, street car heaters, radiators, sterilizers, medical appliances, motor rheostats, controlling devices, theatre dimmers, etc. The accompanying illustrations show some of these, Fig. 1 showing a melting pot and soldering iron; Fig. 4 a laundry iron stand; Fig. 2 a rheostat; Fig. 3 a car and stateroom heater, and Fig. 5 some cooking utensils. In the "Prometheus" system no wires are used. The heating device itself consists of a strip of mica on which a layer of metal has been deposited, or more properly speaking, fired. This conducting strip is protected by another piece of mica, and the whole is enclosed in a metallic casing. This unit or "heating element" can be painted to any desired resistance. The paint is an alloy composed of non-oxidizable metals, ensuring the element's life. The element may be either straight or circular, according to its usage, and may be inserted into or removed from a piece of apparatus with the greatest ease. The numerous advantages of electrically equipped heating and cooking apparatus, such as the riddance of smoke and soot, no vitiation of the atmosphere, instant heat at the exact place where it is wanted, no fuel or large cooking range, no labor in making or maintaining the fire, no waste of heat, perfect regulation of temperature, no danger from fires or explosions, cleanliness, etc., have all been recognized by those interested in the introduction of electricity into home and workshop for a number of years, but well-grounded causes, such as the almost prohibitive cost of current, are responsible for the somewhat limited but nevertheless growing use of electrically equipped cooking and heating apparatus.

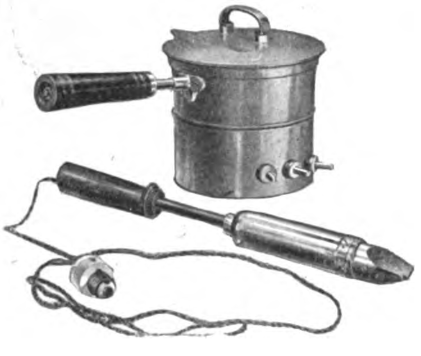


FIG. 1.—MELTING POT AND SOLDERING IRON.

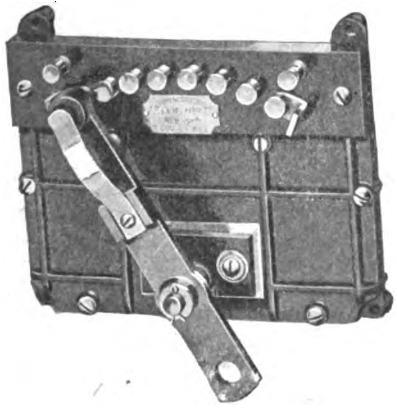


FIG. 2.—RHEOSTAT.

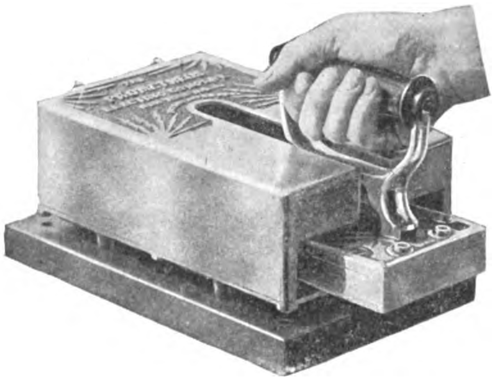


FIG. 4.—SAD IRON HEATER.

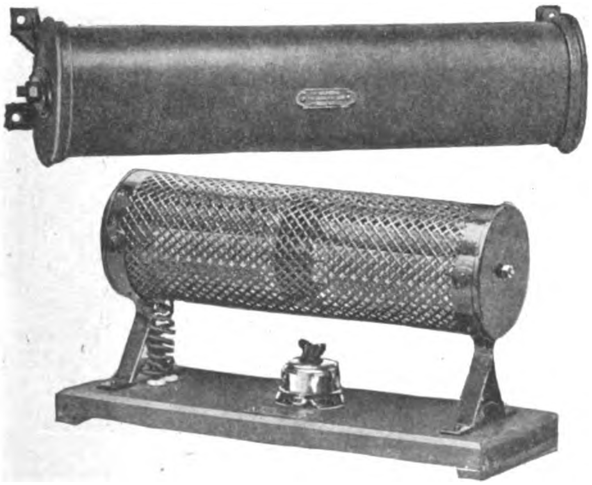


FIG. 3.—CAR AND STATEROOM HEATERS.

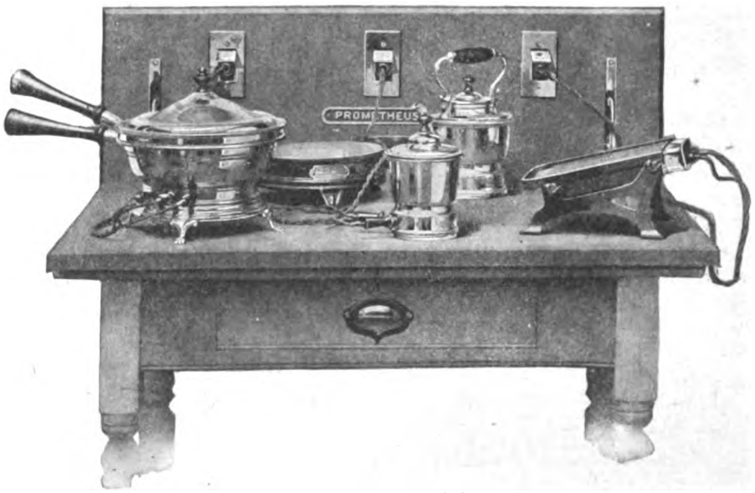


FIG. 5.—COOKING UTENSILS.

GAS ENGINE IGNITERS.

The Holtzer-Cabot Electric Company, Boston, Mass., has supplemented its line of gas engine igniters with a larger size, a machine exceeding, it is said, in size and output anything else of the magneto type on the market. It weighs 30 lbs., and has a capacity momentarily of 50 watts, and continuously of about 25 watts. The armature is of the slotted drum type, with laminated core. A compound winding is provided, which holds up the field under load, making possible a much greater output than could be obtained in a magneto of the usual construction. Particular attention is directed to the brush-holder, which is of the box type, with parallel feed, substantially constructed, allowing a brush of relatively large cross section to be used. A sliding base is provided, with a thumb screw for tightening the belt. The machine is used to advantage with large engines and those whose "make-and-break" device is of such construction as to require a relatively large quantity of current. It combines the large output of the dynamo igniter with the advantages

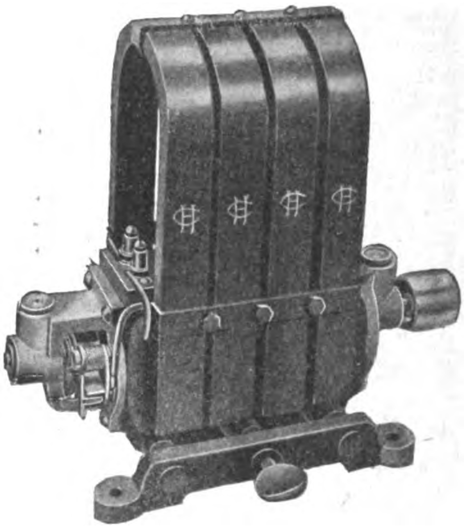


FIG. 6.—GAS ENGINE IGNITER.

of the magneto type, namely, reversibility, independence of speed fluctuations, and ability to deliver a spark at a very low speed. These features also make the igniter useful in connection with automobile work, where the weight would not be a disadvantage.

COMBINED VOLTMETER AND AMMETER.

Fig. 7 herewith represents a new volt-and ammeter, one of the line of small measuring instruments made by Louis M. Pignolet, of New York. The instruments are twice the size of the engraving, and though small enough to be carried in the pocket are large enough for all practical purposes. They are made in various ranges and combinations for electric light and battery circuits. The one illustrated has three ranges, namely, 0 to 6½ volts in tenths, 0 to 130 volts in two-volt scale divisions, and 0 to 15 amperes in half-ampere divisions. Thus the same instrument can be used for measuring the e.m.f. of an electric light circuit or that of a single cell of battery, besides measuring current strength up to 15 amperes. This makes a useful combination and enables the instrument to be employed for a large variety of purposes, such as testing electric light and battery circuits, measuring the potential difference of arc lamps, the e.m.f. of primary or storage batteries, etc. The instruments are of the permanent magnet type and are made in the same way as a large portable instrument except the parts are smaller. The magnets are of special imported steel carefully treated to insure permanency. The pivots of the moving parts are sharp and hardened, and rest in jewels. The scales are inked in by hand and have divisions of practically equal width.

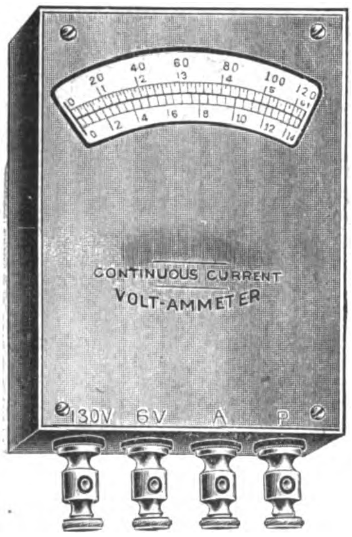


FIG. 7.—COMBINED VOLTMETER AND AMMETER.

JUNCTION BOX.

The Sprague Electric Company recently made another advance in the matter of junction boxes that will be of great convenience to contractors and others. The accompanying illustration shows the adaptation of lead bushings to a side wall box whereby one box can be made to fit a variety of sizes of conduit from ½ inch down, or a variety of conduit, cable and cord. This obviates the necessity of having to obtain different sizes of boxes for different sizes of conduit, etc.

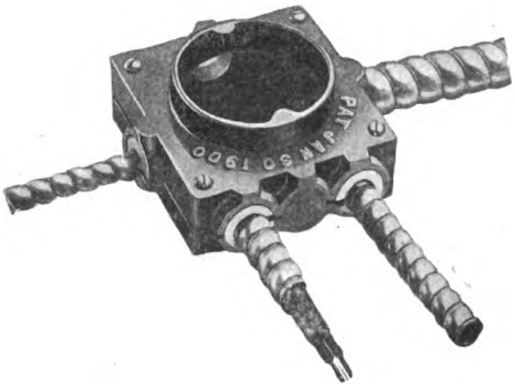


FIG. 8.—JUNCTION BOX.

BORING MACHINE FOR WIREMEN.

Fig. 9 herewith shows a handy device for wiremen, brought out by the G. & E. Electric Company, of Binghamton, N. Y. The machine is designed to bore holes through joists at right angles, using different sizes of bits. The operator may manipulate the machine while standing above or below the joist. A spring lever connecting with a sliding shaft feeds the bit as the boring progresses, and a reversal of the lever retracts the bit when the boring is complete. The machine is self-supporting when in position, and is operated from the floor through a chain and sprocket gear, as shown.

ACME HIGH-SPEED STATIONARY ENGINE.

The Rochester Machine Works, of Rochester, N. Y., is manufacturing a small engine especially adapted for high speed direct-coupled work, such as driving electric generators, a combined unit being shown by Fig. 10 herewith. The engine is made in sizes ranging from ½ to 8 horse-power, the rating being based upon a steam pressure of 100 lbs. The frame is, however, designed to withstand a working pressure of 200 lbs. The engine is an upright, double-cylinder, self-acting; with cranks set 180 degs. to each other. The valves are of the balanced rocking type, having extra long and large wearing surfaces; they are placed on top of the cylinders, the valve case forming the cylinder heads. This arrangement gives opportunity for long ports, resulting in quick admission and release, and makes the action of the cut-off governor sensitive to the slightest change in speed or load. The flywheel is of cast-iron, turned true and balanced, and has within its periphery the automatic governor, which regulates the admission of steam to suit the varying loads, by changing the throw of the eccentric that actuates the valve. This automatic governor is very simple, consisting of only four pieces, and is peculiarly adapted to a high-speed engine where an even speed is essential. Lubrication is accomplished by carrying in the crank-case a mixture of oil and water, into which the cranks dip at every revolution. The

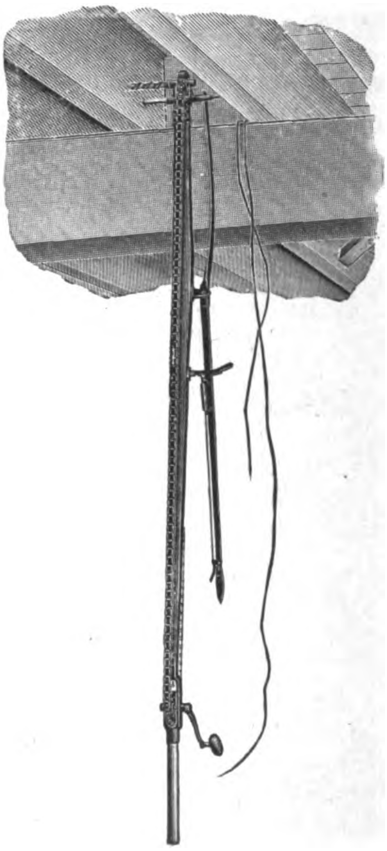


FIG. 9.—BORING MACHINE.

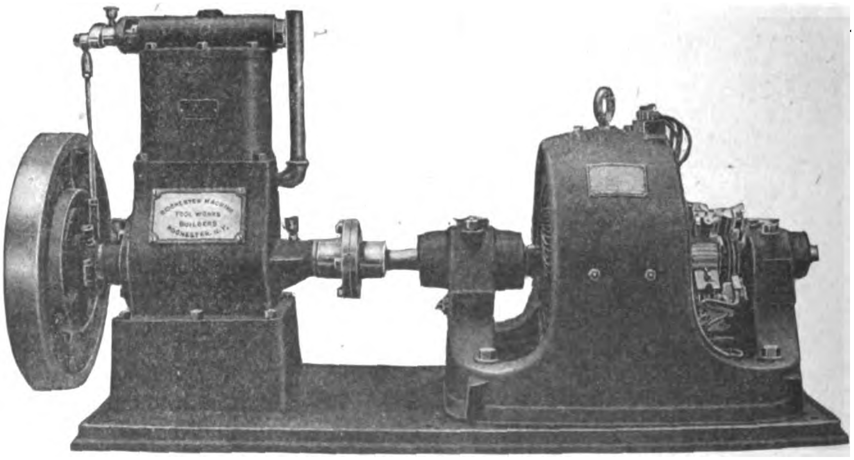


FIG. 10.—ACME HIGH-SPEED STATIONARY ENGINE.

cranks are thereby not only lubricated themselves, but they throw the oil to every part inside the case, the wrist-pins in the hollow pistons getting a good supply at each stroke and also the lower part of the cylinders. As the oil cannot escape it is used over and over, that supplied to the main bearings being caught up by wipers and returned to the crank-case. The eccentric rod strap, and bearing, and the outer bearings of the valve-stem are the only bearings not constantly oiled while the engine is running. The following advantages are claimed for the engine: Continuous lubrication without waste of oil; smoothness and silence in operating at high speed; absence of stuffing boxes; and freedom from liability to get out of order, the working parts being reduced to the smallest number and being securely fastened to the proper adjustment. All parts liable to wear are made interchangeable.

"CECO" ELECTRICAL MACHINERY.

The Christensen Engineering Company, of Milwaukee, has just placed upon the market complete new lines of "Ceco" electrical machinery, including direct-current motors and generators, alternators and transformers. For several years this company has been manufacturing electric motors for driving air compressors used in connection with the well-known Christensen air brake equipments on electric cars. The company has also built a large number of motors of various capacities for driving air compressors used in general commercial service, and all the motors for driving machine tools and shafting in their own works.

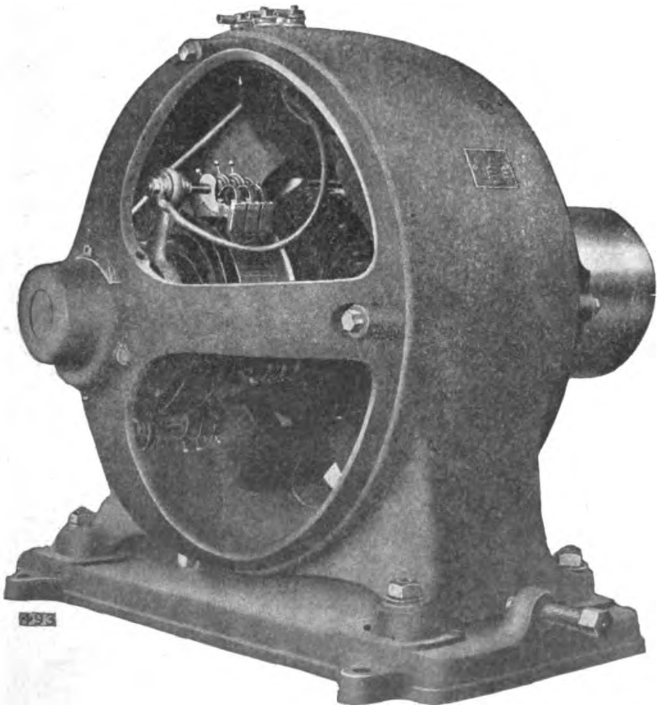


FIG. 11.—DIRECT-CURRENT MOTOR.

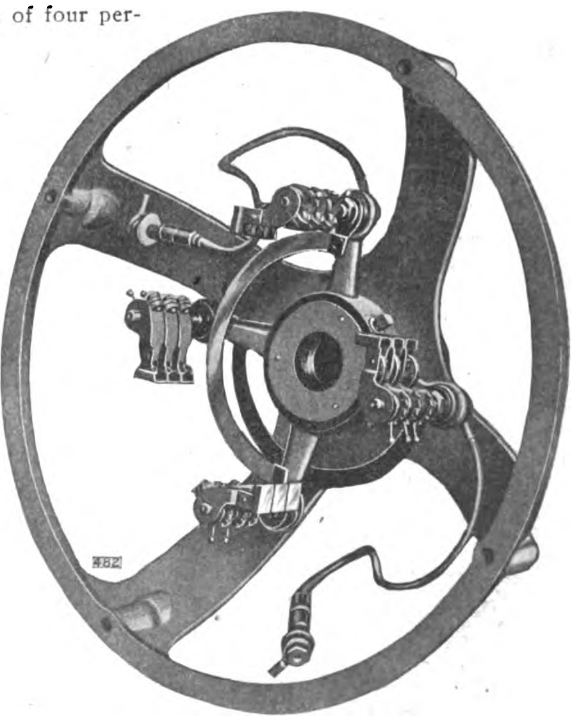


FIG. 14.—MOTOR BEARING BRACKET AND BRUSH HOLDERS.

The company is now prepared to build machines up to 1500 kw. in capacity, suitable for general power, railway or lighting service.

The line of "Ceco" motors known as Type C. E., ranging in capacity from 2 to 50 h.p., is illustrated herewith. These motors are made in three styles, open, semi-enclosed and enclosed. The standard styles are belted, but any motor can be geared or direct-connected to the driven machine or shaft. The C. E. motors are for general service in industrial establishments of every kind where a high grade, durable and reliable machine is required.

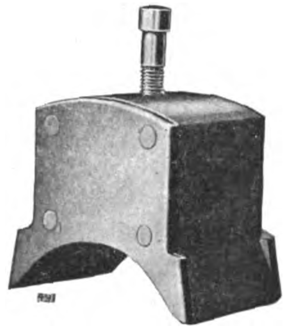


FIG. 12.—MOTOR POLE PIECE.

The frame or yoke to which the poles are secured is cylindrical in shape, and is composed of a single steel casting; the bearing brackets being secured to the frame by bolts. The terminals are mounted on top of the frame, where they are readily accessible in case it is desired to change the connections in order to reverse the direction of the motor. The two bearings are supported by two end brackets, which are identical and interchangeable so that the motor is symmetrical and pleasing in appearance. The semi-enclosed type is the same as the open, but with the addition of four perforated malleable iron cover plates. The plates fit into the four open spaces between the arms of the end brackets, and can be quickly and easily removed or replaced. The enclosed type of motor is the same as the semi-enclosed, except that the cover plates are solid instead of perforated. Either style of cover plates will fit into the open type of motor, consequently the same motor may be used as open, semi-enclosed or enclosed.

The field poles are built of laminated sheet steel, thereby avoiding eddy current losses. The larger machines have four poles, and the smaller sizes are built with two only, thus permitting the use of a commutator that can be insulated far more satisfactorily than is possible in small machines of the usual four-pole construction. The poles are bolted to the yoke so that a rigid construction is obtained, and the pole is easily removable without disturbing the armature.

The field winding is composed of machine-formed coils, accurately wound by automatic machinery. Any field coil can be readily and quickly removed without disturbing the armature by simply withdrawing the pole.

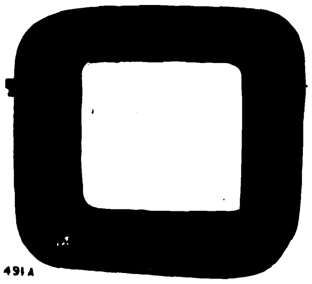


FIG. 13.—MOTOR FIELD COIL.

The armature core is built up of punched discs of soft sheet steel slotted around the periphery to receive the armature winding. These discs are re-annealed and insulated after being punched, before assembling.

The shape of the punching is such, that when assembled on the steel shaft openings are provided for ventilation parallel to the shaft. Additional ventilation is secured by the use of radial air ducts.

The armature coils are all machine wound. Those for the smaller motors are of wire, while those for the larger sizes are composed of copper bars. The coils are all carefully insulated, then dipped into a bath of special insulating compound, and finally placed in a drying oven until they are thoroughly baked. Surface bands are used to retain the coils in the slots on the smaller sizes, while the same result is secured in larger sizes by the use of retaining wedges placed in specially provided notches near the top of each slot. As the core and poles are constructed of soft laminated steel, it is evident that the magnetic circuit which consists of these three elements, is of high permeability and the efficiency of the motor is therefore correspondingly increased.

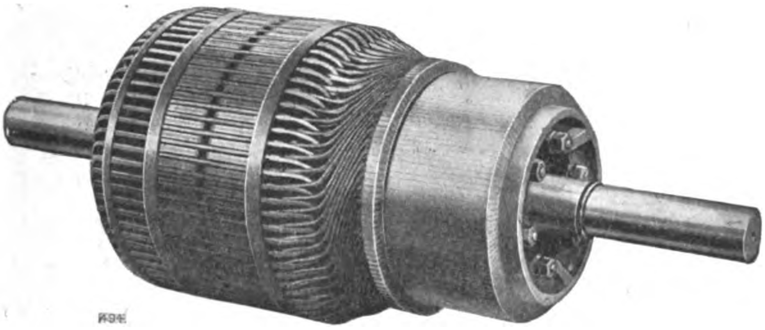


FIG. 15.—MOTOR ARMATURE.

The commutator is built up of copper segments insulated from each other by sheets of mica. The segments are of generous length and depth, insuring cool running, and allowing ample margin for wear. The commutator is easily removable from the armature shaft, tapped holes being provided in the face of the commutator sleeve for that purpose. As the commutator is usually the cause of more trouble than all other parts of a motor combined, unusual care has been given to its design and construction. Carbon brushes are used, and the brush holders are of the Christensen Company's coil spring reaction type. They are very simple in design and reliable in operation. The brush holder studs to which the holders are secured are mounted upon a yoke, which is fastened to the inner side of the bearing bracket. Each brush can be readily adjusted, and any brush can be quickly and easily removed while the motor is running.

The brush contact area is in all cases ample for the current to be commutated the current density being very low and at the same time consistent with economical design. Wear of the commutator is provided for by radial adjustment of the brush-holder studs. After the brushes are properly set no shifting is required, and the motor operates without noise and without sparking. The bearing surfaces are generous in area. Self-aligning babbited bearings with the well-known self-oiling ring arrangements are provided. The motors are mounted on a cast iron sub-base, which is composed of a single casting, thus insuring perfect alignment. Belt tension is accomplished by moving the motor upon the sub-base in the usual manner. The ventilation of the armature and commutator is said to be remarkably good. The motors are designed to operate at their rated loads without the temperature of the armatures rising more than 30 degs. C. The rise in temperature of the field coils under these conditions does not exceed 40 degs. C., and of the commutator 45 degs. C. The machines are said to operate from no load to full load with the brushes in a fixed position without sparking, and also to operate for two hours with 25 per cent. overload and for two or three minutes with 50 per cent. overload without injurious heating or sparking.

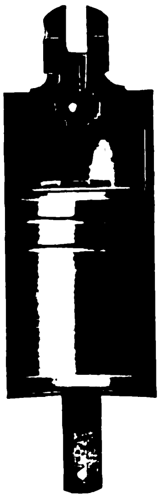


FIG. 19.—DAYTON DASHPOT.

NEW TYPE OF ENCLOSED ARC LAMP.

The Dayton Fan and Motor Company, of Dayton, Ohio, has brought out a new type of arc lamp, in which a new controlling mechanism has been introduced, the multiple system of gas chambers remaining the same as in all types of the "Belden" lamp. Instead of being rigidly connected to the lamp frame, the solenoid is pivoted to one end of a walking beam to the other end of which the movable carbon tube is pivoted. The principal advantages claimed for this construction are that the weight of solenoid tends to balance the weight of the movable carbon and tube; the solenoid has a double power when energized by a direct upward pull on the tube and downward pull on solenoid or opposite end of walking beam; any change in ampere-turns, due to changes at the arc, has a double effect of making the lamp very sensitive; and each ampere-turn having double power, allows the use of a very small solenoid, thus reducing the cost of manufacture and expense of repair parts. Fig. 16 is a view of the movable mechanism, which is pivoted to walking beam at *D*, the upper end being movably connected to the lamp frame at *A*. Loops are brought out on the solenoid at *G F E* for ampere adjustment. A clamp is shown at *H* for voltage adjustment. This entire mechanism is assembled as one piece by the use of but two nuts, shown at *B*. Fig. 17 shows a lamp for outdoor use. This lamp is but 25 ins. long over all; the body of case is 4½ ins. in diameter, the outer globe 11 ins. in diameter, and the

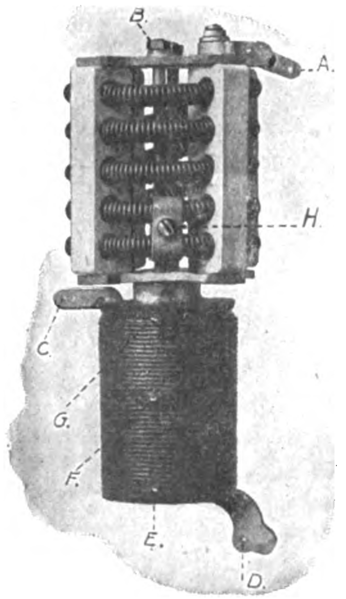


FIG. 16.—MOVABLE MECHANISM.

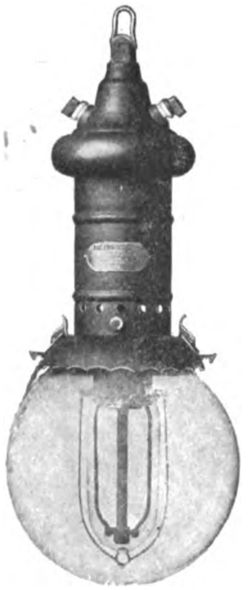


FIG. 17.—OUTDOOR LAMP.

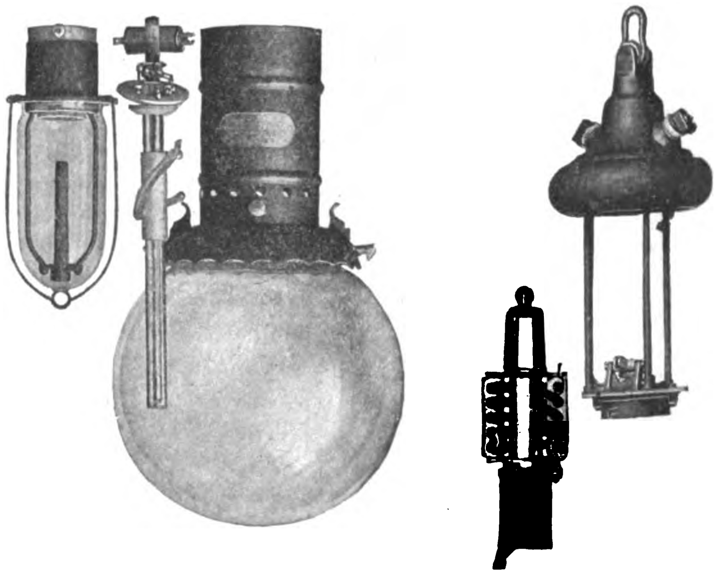


FIG. 18.—LAMP DISASSEMBLED.

standard carbons 12 x ½ ins. for 5 or 6 amperes, and 12 x ⅜ ins. for three amperes. Fig. 18 shws lamp disassembled into five sections, this requiring the removal of but two cotter pins, and the breaking of but two connections, and can be accomplished in 30 seconds' time. Fig. 19 shows the dash pot. The valve in the top is a 3-16-in. ball, made of a special metal to prevent rust and corrosion. The plunger is made of a very fine high-grade graphite. The upper part or casing is pivoted to the movable mechanism and the plunger to the walking beam, which causes them to move in opposite directions, giving a very long, rapid movement, and controlling the lamp perfectly with a very loose fit, which obviates trouble from expansion and contraction common to snug-fitting dash pots.

NEW BOOK.

Easy Lessons in Mechanical Drawing and Machine Design. By J. G. A. Meyer and Charles G. Peker, New York: Industrial Publication Company. Cloth. Vol. I, 405 pages, 10 ins. x 13 ins.; many illustrations; price, $6. Vol. II, 268 pages, illustrated; price, $4.

This is a very comprehensive and intelligible manual intended, and well qualified, for self-instruction on the part of the reader. The author understands his subjects, and expounds them clearly and without prolixity. A feature which appears to the reviewer to be rather detrimental, however, is the alternation of the drawing lessons with those on machine design. The first part of Chapter I, for example, is devoted to an elementary explanation of free-hand, geometrical and mechanical drawing, and the second part of the same chapter contains full working drawings of an engine lathe, accompanied by an explanation of the various parts, materials, etc., which would be unintelligible to most men requiring the first part of the chapter. It would seem that a more logical disposition would have been to let the discussion of machine design follow after the final lesson in drawing. The books are well executed typographically, and the cloth-bound volumes are very substantial mechanically. The work is also issued in twenty parts, with paper covers, which are sold for 50 cents each.

Notes from the American Street Railway Association Convention.

TRIUMPH ELECTRIC COMPANY, of Cincinnati, was represented by F. W. Haines, of Detroit.

THE SIMPLEX ELECTRIC HEATING COMPANY, of Cambridgeport, Mass., made an exhibit of heaters in the space of the Ludlow Supply Company.

THE KINSMAN ELECTRIC & RAILWAY SUPPLY COMPANY was represented by F. E. Kinsman.

THE AMERICAN ELECTRIC SWITCH COMPANY, of Pittsburg, was represented by W. S. Berry, who made an exhibit in connection with C. J. Harrington.

BALL & WOOD ENGINE COMPANY was represented by J. H. Naishall, of Detroit, and L. A. Parshall.

THE STANDARD VARNISH WORKS, of New York, showed a number of armature coils insulate with its various varnishes and compounds. J. C Dolph was in charge

"THIS IS IT"
ST. LOUIS SECURITY REGISTER
OHMER REGISTRY SYSTEM DAYTON, O.
The International Register Company
THOMAS RAIL BONDS
THE PENNSYLVANIA STEEL CO.
AMERICAN STEEL & WIRE COMPANY
THE GREAGHEAD ENGINEERING CO. CINCINNATI, O.
lectrician
STANLEY ELECTRIC
SC
MANUFACTURING CO.
Chloride Accumulator
HARTON Jr. & CO.
PENNSYLVANIA
ATLAS RAIL JOINT SPLICE
CHICAGO. U. S.

GENERAL VIEW LOOKING FROM THE GALLERY OF EXHIBIT HALL.

CENTRAL ELECTRIC COMPANY, of Chicago, was represented by R. L. Kimble.

SHELBY ELECTRIC COMPANY, of Shelby, Ohio, was represented by Mr. Arthur Reid.

ALLIS-CHALMERS COMPANY, of Milwaukee, Wis., was represented by Jas. W. Lyons.

BUCKEYE ELECTRIC COMPANY, of Cleveland, Ohio, was represented by M. K. Eyre and F. M. Odena.

THE McROY CLAY WORKS, Brazil, Ind., was represented by E. F. Kirkpatrick, western manager, of Chicago.

THE HARRISON SAFETY BOILER WORKS, of Philadelphia, Pa., was represented by Frederick H. Mason, of Detroit.

THE D. & W. FUSE COMPANY, of Providence, R. I., was represented in a neat exhibit made by A. Hall Berry, of New York.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, was represented by H. J. Doyle, manager railway department.

DALLETT & CO., of Philadelphia, dealers in new and second-hand material, showed a G. E.-1000 motor, a number of which they have for sale.

THE H. B. CAMP COMPANY, New York and Chicago, had an exhibition in the smoking room, consisting of samples of various kinds of conduits and underground work.

BULLOCK ELECTRIC MANUFACTURING COMPANY, of Cincinnati, was represented by F. G. Bolles, the energetic manager of the publicity and foreign sales departments.

F. H. LOVELL & CO., of New York, were represented by A. Hall Berry, general manager. They had on exhibition all kinds of overhead material manufactured at their plant at Arlington, N. J.

THE F. BISSELL COMPANY, of Toledo, Ohio, represented by M. S. Walker and C. M. Hamilton, made an exhibit of switchboards and general railway supplies. This company is agent for the Nernst lamp.

THE STANDARD VITRIFIED CONDUIT COMPANY, manufacturers of vitrified salt-glazed underground conduits and third-rail insulators, made an interesting exhibit and Vice-president B. S. Barnard was in attendance.

THE CHASE-SHAWMUT COMPANY, of Boston, made an exhibit of its flexible rail-bond, which is fastened to the rail by soldering, and has been successfully used in a number of cities. The exhibit was in charge of F. D. Masterson.

THE NATIONAL CONDUIT & CABLE COMPANY, of New York, was represented by W. S. Eckard and J. D. Honan, of the home office; F. S. V. Fraf, of the Boston office; L. D. Beylard, Philadelphia, and Harry F. Tate, of the Chicago office.

THE VAN DORN-ELLIOTT ELECTRICAL COMPANY, of Cleveland, Ohio, showed a rewound armature and specimen field coils, armature coils and commutators. The stand was nicely decorated. W. A. Dutton and J. N. Elliott were in attendance.

STANDARD PAINT COMPANY, of New York, had an exhibit in the gallery of its P. & B. paints and electrical insulating compounds, insulating papers, roofing material, etc. The company was represented by J. C. Shainwald, B. C. Beckman and E. R. Willard.

THE NATIONAL BATTERY COMPANY, of Buffalo, N. Y., was represented at the convention by Joseph P. Devin. Mr. Devin reports that the National Battery Company is now in shape to handle installations of any size for electric railway and lighting purposes.

B. H. SCRANTON, president of the American Electric Heater Company, of Detroit, Mich., dropped in at the convention, and was very much interested in the latest developments shown and discussed. The company is very busy in the field of industrial electric heating.

THE JOHN A. ROEBLING'S SONS COMPANY, of New York and Trenton, N. J., had a large representation present, among whom were noticed H. L. Shippey, treasurer; M. R. Cockey and G. W. Swan, of the New York office; George C. Bailey and Mr. Conover, of Chicago; W. P. Boreman, Cleveland, and W. L. Doyle and N. G. Tingley, of Trenton.

SPEER CARBON COMPANY, of St. Mary's, Pa., had an exhibit in the gallery of street railway carbons, under the supervision of J. S. Speer himself. He displayed a full line of their self-lubricating brushes for motors, lighting dynamos and electric railway generators.

THE STERLING LUBRICATOR COMPANY, of Rochester, N. Y., had several styles of its force feed lubricators in actual operation in a prominent stand on the main floor. The device has a positive feed, it will pump against any pressure and can be regulated to supply any amount of oil to any cylinder. An automobile lubricator was featured. J. Sherry was in charge.

THE ELECTRIC STORAGE BATTERY CO. PHILADELPHIA
Chloride Accumulator
Chicago, Detroit, San Francisco, Havana, New York
STANDARD PAINT CO.
P&B
STANLEY ELECTRIC MANUFACTURING CO.
GOLD'S ELECTRIC HEATERS

FOUR HANDSOME EXHIBITS AT THE STREET RAILWAY CONVENTION.

THE AMERICAN BLOWER COMPANY, of Detroit, made no exhibit at the convention hall, but those of the delegates who visited the company's plant in the city were impressed by its magnitude and the excellent facilities there provided for manufacturing the blowers, fans, engines, etc., for which the American Blower Company has established so enviable a reputation.

MERRITT & CO., of Philadelphia, exhibited their expanded metal lockers, and were represented by Stephen Morris. The peculiar advantages of the Merritt lockers are their durability and neatness; the freedom with which they admit light and air; the ease with which they are kept clean and the adequate protection which they furnish. They are already in use in the power stations and car houses of some of the largest electric railway systems of the country.

Gould Storage Battery Co
STANLEY ELECT
AMERICAN STEEL & WIRE COMPANY
H.W.JOHNS-MANVILLE COMPANY.
NEW YORK.
ENCLOSED NOARK FUSES, ETC.
VULCABESTON

INTERESTING EXHIBITS ATTRACTIVELY AND EFFECTIVELY ARRANGED.

CRANE COMPANY, of Chicago, had its usual line of high-pressure steam valves and flanges on exhibition, in charge of Capt. George A. Hurd. A flange in which the joint between the flange and wrought iron pipe was made by rolling the pipe outwardly into grooves in the flange was shown. This rolling is done by special machinery, developed by the Crane Company, and the joint seems likely to be a most popular one, since it is so easily made with special machinery and so tight.

THE STROMBERG-CARLSON TELEPHONE & MANUFACTURING COMPANY, of Chicago, occupied a space in the annex with a line of telephones suited to the requirements of street railway service. The Milwaukee Electric Railway & Light Company has over 200 Stromberg-Carlson instruments in use. The switchboard shown had visual lamp-line signals and magneto signals, and a combination of connecting cord circuits, adapted for interconnecting the various systems. J. J. Nate and A. J. Rousseau were in attendance.

VALVES
FITTINGS
AND
WROUGHT PIPE
CRANE CO.
CHICAGO
ESTABLISHED 1855
COMPLETE
PIPING
EQUIPMENT
POWER PLANTS

FAMILIAR TO ALL STEAM MEN.

American Electric Switch Co
Pittsburgh Switch & Signal Co
PITTSBURGH PA.
VITRIFIED
CAST WELD
Incandescen

AMERICAN ELECTRIC SWITCH COMPANY'S EXHIBIT.

THE H. W. JOHNS-MANVILLE COMPANY, of New York, made a neat exhibit of its overhead line supplies of all kinds of rail-bonds, electric car heaters, molded mica, Monarch and vulcabeston insulating materials, and the Sachs "Noark" enclosed fuses. This company was well represented by J. W. Perry and J. E. Meek, of New York; S. H. Finney, of Chicago; W. A. Buddecker, of St. Louis; T. F. Becker, of Milwaukee; T. D. Dickson, of Philadelphia, and E. B. Hatch and W. A. White, of the Johns Pratt Company, Hartford.

THE NATIONAL CARBON COMPANY, of Cleveland, had its usual complete exhibit of various products of the Cleveland and Sandusky plants. Among other goods were shown Partridge, Solar and National commutator brushes in various grades, and the Columbia wire gauze and plumbago types; Columbia arc carbons for headlights and enclosed arc lighting; also auto cells and Columbia dry cells for automobile and gasoline engine sparking. James Partridge, manager of the Partridge works, Sandusky, and R. K. Mickey, of Cleveland, were in charge.

THE AMERICAN STEEL & WIRE COMPANY had its customary prominent exhibit, consisting of reels of wire, cable, wire rope, wire fence and bonds and springs. Wire was shown both bare and insulated, and neat leather pocketbooks were distributed as souvenirs. The stand was handsomely decorated with cut flowers and palms. The company was well represented by C. S. Knight, Jr., Chicago; W. C. Bogne, Detroit; J. A. McQuale, Jr., Philadelphia; J. D. Sutherland, Pittsburg; George Chandler, Dayton; H. F. Pratt, Cleveland, and N. H. Van Sicklen, Chicago.

THE CROCKER-WHEELER COMPANY, of Ampere, N. J., was represented by Putnam A. Bates, assistant secretary, and C. W. Startsman, of the home office; Managers F. B. De Gress, Julian Roe, W. H. Wissing and W. F. Sullivan, of the New York, Chicago, St. Louis and Cleveland offices, respectively, and W. J. Hartwig, local representative for the Detroit territory. The company issued several handsome circulars descriptive of Crocker-Wheeler apparatus in Detroit and elsewhere, and gave a most delightful trolley party over one of the picturesque routes out of Detroit.

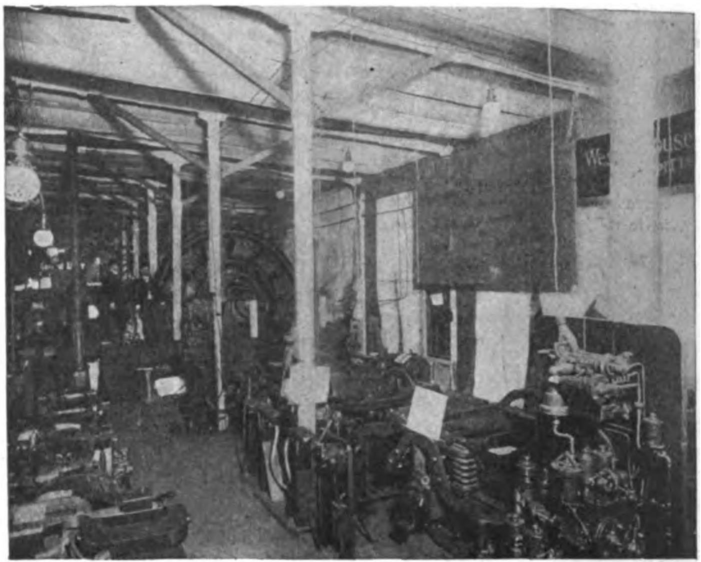
KELLOGG SWITCHBOARD AND SUPPLY COMPANY, of Chicago, made one of the most extensive telephone exhibits ever offered at a street railway convention. Telephones of special interest to street railway men were shown, and there was also a standard common battery switchboard with many different types of instruments connected thereto. R. H. Manson, of the engineering department, and F. L. Martin, advertising manager, looked after the exhibit. This company is now catering to the street railway field in the same excellent manner that it has handled large exchange work.

N. A. CHRISTENSEN, of Milwaukee, made a separate exhibit from that of the Christensen Engineering Company in the annex. Here he showed a motor-driven air compressor for use in shops, power houses, etc., for furnishing compressed air for cleaning purposes, for pneumatic tools, etc. Mr. Christensen stated that he now has facilities for turning out these self-contained compressors in sizes up to 175 horse-power. The motor for driving the compressor is provided with the standard type of automatic cut-in and cut-out control, which throws the motor on the circuit direct, without resistance control.

THE STUART HOWLAND COMPANY, of Boston, was ably represented by H. W. Smith from the main office and H. De Steese, of the New York branch office. A full line of overhead specialties were shown at the Cadillac, consisting chiefly of standard types of flexible brackets and their now well-known forms of overhead suspensions, for both single and double trolley, of which 808 miles have been sold and delivered within the past seven months. Each guest was appropriately decorated with a unique souvenir, in the form of a medallion, bearing the legend "808, Detroit, 1902," to which was suspended a miniature facsimile of the company's famous "III rib" trolley wheel.

KELLOGG SWITCHBOARD AND SUPPLY CO. CHICAGO
MANUFACTURERS OF
HIGH GRADE TELEPHONE APPARATUS AND SYSTEMS.

SOME WELL-KNOWN TELEPHONES.



A CORNER OF THE WESTINGHOUSE SPACE.

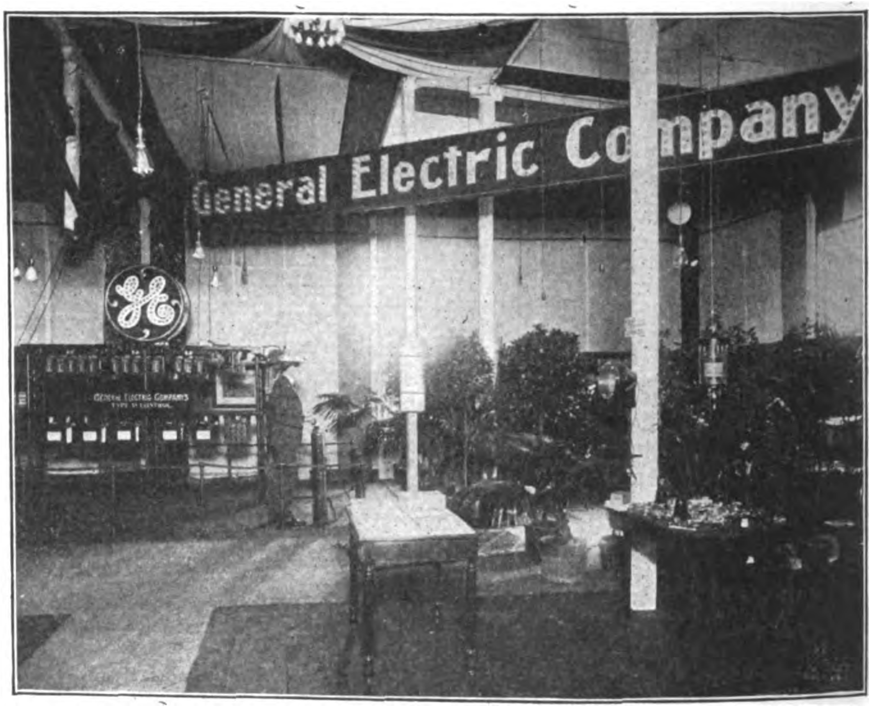
GOULD STORAGE BATTERY COMPANY, of New York, occupied Booth 3, and had a very attractive exhibit of samples of their plates from the small size, 3 in. x 3, up to the largest types for central station work. Glass tanks and lead-lined tanks were also on view, showing the special form of glass covers for preventing spraying of acid. A number of framed photographs of railway batteries and boosters in various plants were also shown, and copies were distributed of Bulletin No. 2, devoted to the Gould booster system. The exhibit was under the management of W. W. Donaldson, sales manager; E. L. Draffen, manager of the Chicago office, and A. B. Herrick, electrical engineer.

THE STANDARD UNDERGROUND CABLE COMPANY, of Pittsburg, made its usual handsome exhibit of samples, showing various cables in use for street railway work. The important announcement was made that this company is just completing a new copper rod and bare wire mill alongside its present factory at Perth Amboy, N. J., and will be prepared about the last of this year to make not only the bare wire for its own use in making insulated wire, but will be in the market with bare and weatherproof wire in addition to its cables. J. R. Wiley, manager Western sales department, Chicago; H. P. Kimball, of New York; A. A. Anderson and F. S. Viele, of Pittsburg, were present.

THE LE VALLEY VITÆ CARBON BRUSH COMPANY, represented by its president, J. V. Clarke, displayed an assortment of the various shapes, sizes and grades of carbon brushes in its line. Long life, high conductivity and smooth wearing qualities are claimed for this brush. Exhibited in a case were a number of brushes which had been in use on prominent roads for remarkably long periods of time. One sample used on a Westinghouse No. 49, on the Tarrytown, White Plains & Mamaroneck Railway, showed but 1/8-in. wear in 16,836 miles. Another brush, tested by the Lorain Steel Company on one of its motors, showed 7-16-in. wear in 14,000 miles. Souvenir brushes were distributed.

C. J. HARRINGTON, of New York, had a complete exhibit of Empire overhead material, which he manufactures. Mr. Harrington also carries a full line of other electrical railway supplies of all kinds. He is Eastern agent for the Heil cast-welded rail-joint, and recently closed a contract in Pittsburg for several thousand 9-in. girder joints. J. P. Heil, president of the Heil Rail-Joint Welding Company, made his headquarters at Mr. Harrington's exhibit, where samples of joints and photographs of work were to be seen. Mr. Harrington also called attention to the "New Yankee" drill grinder, made by the Wilmarth & Marman Company, Grand Rapids, Mich., for which he is agent.

THE CHRISTENSEN ENGINEERING COMPANY, Milwaukee, had a very large and interesting exhibit across one end of the hall, including a straight air brake-school equipment, and an automatic air-brake multiple unit equipment, both of which were in operation; also a Christensen portable motor-driven air compressor in operation by means of a hook connection to a trolley wire. The company also exhibited some of its new electrical machinery, which it is just putting out for the first time, including a 250-kw. three-phase 2200-volt alternator; a 30-h.p. 500-volt open motor and a 4-h.p. 500-volt enclosed motor. The company distributed very attractive booklets of its air brake and electrical machinery. The company's interests were cared for by F. C. Randall, manager sales department, New York, and J. T. Cunningham, Eastern sales agent, New York, together with a veritable host of other sales agents and engineers connected with the compny.



PART OF THE GENERAL ELECTRIC COMPANY'S EXHIBIT.

THE OHIO BRASS COMPANY, of Mansfield, Ohio, as usual occupied a large and prominent space, very tastefully arranged. The space was surrounded by different types of mounted flexible pole brackets, and the rail around the space consisted of sections of 100-lb. T-rail, joined with fish-plates and bonded with this company's "all wire" rail-bonds, in which the heads are formed from the bunch of wire itself. These T-rails were mounted on different forms of Ohio Brass Company third-rail insulators, including the new Gonzenbach type used on the Aurora, Elgin & Chicago Railway. Inside the space this company's numerous products in the way of overhead material and bonds were displayed on circular stands. The exhibit included also the Monarch track cleaner. This company's representatives were F. B. Black, president; C. K. King, secretary; W. M. Garland, manager New York office; O. W. Uthoff, manager St. Louis office; G. A. Harwood, general agent; A. L. Wilkinson, H. C. Schwable, G. A. Mead, electrical engineer; Burt Gellatly, manager Pittsburg office; E. O. McCormick and C. N. Manfred.

THE WESTERN ELECTRIC COMPANY had as representative at the convention, R. H. Harper, of its railway department at Philadelphia.

THE PENNSYLVANIA ELECTRICAL & RAILWAY SUPPLY COMPANY, of Pittsburg, was represented by Samuel F. Hammond.

THE CUTTER ELECTRICAL & MANUFACTURING COMPANY, of Philadelphia, was represented by William M. Scott, general manager.

THE AMERICAN CIRCULAR LOOM COMPANY had an exhibit ot circular loom with especial reference to car wiring and street railway needs. J. L. Kirkland, of New York, and Thomas G. Grier, Western manager, of Chicago, were in attendance.

THE AMERICAN UNION ELECTRIC COMPANY, of New York, the recently formed consolidation of interests which operates the Morris Electric Company and several others, was represented by Elmer P. Morris, E. Packer and J. Fountain, Jr. One corner of the north gallery was artistically decorated with Morris rail-bonds, Morris fare registers, Falcon switches, trolley wheels, trolley harps, pole brackets, overhead line material, signs and other Morris products. Mr. Morris distributed a neat brochure among his friends containing illustrated yarns of salesman life.

THE GARTON-DANIELS COMPANY, of Keokuk, Ia., the well-known lightning arrester maker, exhibited the Knox "Automotoneer" for limiting the rate at which a motorman can advance his controller handle which has been improved by several years of hard work. It is simpler and more substantial than the forms presented at any of the four preceding conventions. J. V. E. Titus, secretary of the company, who was in attendance, gave out to those desiring it a new catalogue describing the construction of the device and presenting technical arguments in favor of its use.

THE A. & J. M. ANDERSON MANUFACTURING COMPANY, of Boston, made a leading feature of a new section insulator which they have recently devised and which was one of the neatest novelties in overhead material exhibited. The insulating section on which the trolley wheel runs is detachable instantly for renewal, and the ends to which the trolley wire is fastened are so hooked to the main frame that they can be taken off by taking the tension off the wire. The device was very favorably commented on. Ernst Woltmann and H. F. Sanville, of the Philadelphia office, represented this well-known firm.

EUGENE MUNSELL & CO. and THE MICA INSULATOR COMPANY, of New York, were represented at the convention by Charles E. Coleman, manager for both concerns at Chicago. Mr. Coleman had a very prominent location in the center of the hall. "Micanite" and "Empire" insulating materials were exhibited in their various forms, and the company's circular matter was distributed, which included a very neat blotter, which was at the writing rooms of the various hotels. The company reports a heavy demand for all its mica and micanite specialties, and has just completed an addition to its already extensive works at Schenectady, which will give it increased capacity of 6,000 square feet of floor space.

THE DEARBORN DRUG & CHEMICAL WORKS, of Chicago, had a tastefully arranged booth decorated in white. Robert F. Carr, vice-president and general manager; W. B. McVicker, second vice-president and Eastern manager, of New York; O. L. Flugel, Detroit, and Grant Spear, Chicago, explained the advantages of the company's treatment of boiler feed water. On a stand there was a model of the company's boiler compound feeder which is attached to the boiler feed-pump rod and distributes any desired quantity of the compound. There were a number of samples of tube sections showing the effect of the scale, pitting and other boiler tube troubles. There were also exhibited samples of the company's line of lubricating oils. The stand was a Mecca for souvenir hunters; among the free offerings being black diamond stick pins, cigar fans, puzzles and cut-glass bottles of perfume for a chosen few.

WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY had a splendid exhibit of apparatus, the most prominent item of which was a 1,500-kw. rotary converter of standard type. The ease with which the installation of this great machine was effected and the machine set in operation was certainly striking. Another notable exhibit was the set of multiple control apparatus consisting of sets of controllers, etc., for two cars, and four motors, all arranged on Baldwin trucks for demonstration. The exhibit of motors embraced various small and large types for urban, suburban and long-distance work. There was also an exhibit of induction motors and transformers. Much attention was also bestowed by delegates on the display of detail apparatus such as starting resistances for cars, canopy switches, automatic car circuit-breakers; over-load circuit-breakers, iron fuse-blocks, lightning arresters, and voltmeters and ammeters. The exhibit was indeed one of the most complete and effective that a great manufacturing company has ever sent to a street railway convention. Appropriate literature was distributed, and a large number of representatives on hand to conduct the exhibit, etc., among whom were Vice-president F. H. Taylor, W. M. Probasco, L. A. Osborne, Arthur Hartwell, W. H. Whiteside, C. E. Skinner, A. Whitley and J. M. Duncan, of Pittsburg.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, of Pittsfield, Mass., had space in the center of the exhibition hall, and displayed the heaviest and largest piece of machinery in the exhibition hall proper. The machine referred to was one of the standard S. K. C. rotary converters, similar to those in use on the Flint division of the Detroit United Railway, the Oley Valley Railway Company, of Reading, Pa., and the Kansas City & Leavenworth Railway, of Kansas City. Its liberal design at once commanded attention. The exhibit was essentially a complete S. K. C. sub-station equipment, including, besides the rotary, a three-panel switchboard, instruments, circuit breakers and switches. One panel is reserved for the alternating current supplied to the converter, another for the direct current coming from the machine, and the third is a double-feeder panel. All direct-current instruments are on the positive side of the circuit, the negative leads from the converter being mounted upon a separate pedestal arranged for connection to the rail through a special single throw, single-pole quick-break switch. This pedestal also carries the equalizing switch, which is a duplicate of the negative switch. Much of the completeness and success of the Stanley Company's representation at the convention was due to its energetic Michigan representative, Joseph E. Lockwood, president of the Michigan Electric Company. The Stanley Company was represented also by Dr. F. A. C. Perrine, president of the company; Messrs. Van Deventer, Arnold and Bergenthal, of the Chicago office; S. T. Dodd, engineer of the railway department; D. B. Rushmore, from Pittsfield, and Mr. Hough, from the New York office. Ray D. Lillibridge, who is the efficient advertising agent for the company, was also in evidence.

GENERAL ELECTRIC COMPANY'S exhibit was located in the corner of the annex and occupied 2000 sq. ft. of space. The principal feature was an installation of the type "M" control now in use on the Manhattan Elevated Railway in New York City. This exhibit was mounted on a frame which permitted free examination of the parts during its operation and showed the increase in speed of the motors. To indicate the rise in voltage which is a measure of the speed acceleration, a number of incandescent lamps were used, grouped in the form of the company's monogram, and which started at a dull red and gradually came up to full candle-power. Other General Electric apparatus for electric railway service exhibited consisted of a line of railway motors of various sizes, including the 125-hp. GE-66 motor which has been adopted by the Manhattan Railway Company. A Brill 27-E truck was shown with two GE-57 motors mounted upon it and equipped with the company's new type of shoe for use on the protected third-rail system. This latter was exhibited for the first time. There was also exhibited in operation, General Electric air compressors of standard types with automatic governors, connected to a standard reservoir. A type-H electrically controlled oil-break switch with a capacity of 300 amperes at 12,000 volts made a very interesting operating exhibit, the switch being installed substantially as in actual service. Direct and alternating-current rotary converter switchboard panels of standard types were also shown. Among the small supplies exhibited may be mentioned a 6000-ampere carbon-break circuit-breaker for railway use, besides smaller sizes of the same type, and an attractive stand of rail-bonds, incandescent lamp sockets and other small devices. Another feature of considerable interest was a 50-ft. interurban car lent by the Jackson and Suburban Traction Company and used by the company in demonstrating the system for operating such cars. This car was equipped with the type "M" control and 4 GE-66 (125-h.p.) motors, and was located on the Detroit United Railway Company's tracks at a point near the convention hall; it was used by the delegates and their friends for rides around the city. The General Electric Company was represented among others by W. B. Potter, J. R. Lovejoy, J. J. Mahoney, F. H. Gale, L. R. Pomeroy and E. H. Mullin.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, manufacturers of the Chloride accumulator, had on exhibition several standard types of railway cells, ranging from 2600 amperes at the hour rate, to 240 amperes at the hour rate. Several samples of the Exide battery for vehicle service were also on exhibition. Two standard blue Vermont marble switchboards of the type commonly erected by the battery company were installed, showing the apparatus used in connection with railway installations. One of the most interesting features of this exhibit was the special differential-type railway booster. Besides this exhibit on the floor of the armory the company used as part of its display the three batteries on the system of the Detroit United Railway. The first of these batteries consists of 276 G-67 cells installed opposite the main power house of the system. This battery has been in daily operation for the past two years, and by absorbing fluctuations on the system greatly reduces the daily engine hours. Its capacity is 2500 ampere-hours at the hour rate, which capacity is fully utilized once every day on the peak of the load. The second battery, consisting of 250 G-53 cells, was located about two miles from the power house, at the corner of Hancock Avenue and Third Street. Its capacity is 2200 ampere-hours at the hour rate. It is operated in connection with a standard differential type booster. It is used on the peak of the load once or twice a day, as conditions demand, to maintain the proper voltage within a radius of a mile from the battery house. The third battery on this system was located about eleven miles from the power house, on the Wyandotte division at Ecourse. It consists of 276 type F-13 cells of a capacity of 240 ampere-hours at the hour rate. This battery is used as a regulating line battery in connection with a booster operated at the power house end of the line, a feeder running direct to the battery and the line being fed by feeders from this point. During the convention the Battery Company was represented by Charles Blizard, manager, sales department; J. Lester Woodbridge, engineer, sales department; E. Vail Stebbins, manager, Cleveland office; G. H. Atkin, manager, Chicago sales office, R. H. Klauder, manager, St. Louis sales office; R. B. Daggett, manager, San Francisco sales office, and J. E. Lockwood, president of the Michigan Electric Company, the Detroit agent.

OBITUARY.

COL. HENRY A. PIERCE, treasurer and general manager of the Pawtucket Electric Company, died recently from appendicitis. Colonel Pierce was a prominent figure in the political and military circles of Rhode Island, and for ten years was assistant secretary of the United States Senate. He was 66 years old at the time of his death.

WILLIAM C. CLARKE, president of the Sea View Electric Railway Company, died at his home in South Kingston, R. I., on October 8. His death was due to a nervous collapse. Mr. Clarke was largely instrumental in the establishing of the electric light and water plants in his town, and took a lively interest in electrical matters generally. He was 62 years old at the time of his death.

PROF. SIDNEY H. SHORT, the well-known electrical engineer, died suddenly in London on October 22 from appendicitis, as he was preparing to sail for this country. Professor Short was one of the pioneers of the electric railway business, and was formerly identified prominently with the development of the electric railways of America. He was born in Columbus, Ohio, in 1857, and was graduated from the Ohio State University in 1880. After graduation he was appointed professor of physics and chemistry in Denver University, and while in that city built, in 1885, his first electric railway, which was a conduit line. In 1889 he removed to Cleveland, where he organized the Short Electric Railway Company, and soon took a prominent place as manufacturer of electric railway apparatus. After the absorption of this company by the General Electric Company, Mr. Short took a short rest, but was soon invited to engage in his chosen field by the Walker Manufacturing Company, which up to that time had been a large manufacturer of cable machinery. The managers of this company decided to engage in the manufacture of electrical apparatus, and selected Professor Short as its vice-president and electrical engineer. In 1898 the control of the Walker Company was secured by the Westinghouse Electric & Manufacturing Company, and early in 1899 Professor Short went to London, where he accepted the position of technical director of the English Electric Manufacturing Company, a corporation which had recently been organized by British capitalists associated with Dick, Kerr & Co., to build electrical apparatus of all kinds, but particularly for street railway service. Under the direction of Professor Short very large works were erected by the new company at Preston, England. Professor Short's record in England as an electrical inventor and manufacturer was as successful as that in America, and at the request of a number of scientific bodies he presented papers before them on various technical subjects connected with the design of electrical apparatus. Notwithstanding his residence abroad he never gave up his American citizenship, and with his wife made several trips to this country, the last one being on the occasion of the convention of the American Street Railway Association in New York last winter, when he renewed acquaintance with many of his former friends. Personally, he was an extremely agreeable companion, and had a wide circle of warm friends. He leaves a wife, daughter and three sons, the eldest of whom is now taking the engineering course at Cornell University.

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PERSONAL.

MR. W. W. SOUTHGATE, of Nashville, Tenn., has been appointed engineer of the Tennessee Interurban Railway for which surveys are now in progress.

MR. J. L. M'CREARY has been appointed superintendent of electric and motive power of the Federal District Street Railway Company, Mexico City.

MR. MARK LOUD, formerly of Providence, R. I., has been appointed electrical engineer of the Seattle Electric Company, and is now located at Seattle, Wash.

MR. T. M. GATHRIGHT has resigned his position as superintendent of the Camden Interstate Railway Company to accept a responsible position with Col. J. A. Fickinger who is in charge of Senator Camden's extensive mining interests.

MR. JAMES P. GILBERT, formerly general superintendent of the New York & Ohio Company, has been appointed general manager of the Standard Electrical Manufacturing Company at Niles, Ohio, manufacturer of the Standard incandescent lamp.

MR. F. M. HAWKINS, who has heretofore represented the Pass & Seymour interests in New York City, will in future confine his attention to the interests of the Crouse-Hinds Electric Company. His headquarters will continue to be at 23 Dey Street.

MR. C. H. NORWOOD, who formerly represented the Cutler-Hammer Company in Chicago, has been appointed manager of the Chicago office of the Commercial Electric Company, of Indianapolis. Mr. Norwood's headquarters are at 1503 Fisher Building.

MR. A. B. SANDERS, who has for several years been connected with the engineering department of the American Telephone & Telegraph Company at New York, resigned last month to take a position as sales engineer with the Electric Storage Battery Company.

MR. H. S. BURROUGHS, who, for some time past has been identified with the firm of Ballantyne & Evans, has withdrawn from that firm and engaged in electrical and mechanical engineering on his own account with headquarters at 27 William Street, New York.

MR. JOSEPH F. BECK has been elected general manager of the Providence Telephone Company to succeed the late A. C. White. Mr. Beck has been identified with the company for some time past and is well known as a very able and progressive telephone man.

MR. A. E. BARKER, manager of the Kellogg Switchboard & Supply Company's Cleveland office, has been transferred to Chicago where he will be general sales manager for the company. Mr. Arthur B. Kratz, of Philadelphia, has succeeded Mr. Barker in the Cleveland office.

MR. PHILIP DAWSON, the well-known English engineer, has been admitted to partnership in the firm of Kincaid, Waller & Manville, consulting engineers. Mr. Dawson's name has been added to the old firm name so that the style of the firm is now Kincaid, Waller, Manville & Dawson.

MR. GEORGE E. WATTS, who for the past five years has been connected with the Columbia Incandescent Lamp Company, of St. Louis, has resigned his position with that company to go into business on his own account. Mr. Watts will act as special agent for a number of representative manufacturers.

MR. D. CLARENCE DURLAND, who is well known in the electrical field, has been elected second vice-president of the Sprague Electric Company. For the past three years Mr. Durland has been assistant general manager of the company, and his promotion is a recognition of the engineering and executive abilities which he combines to a marked degree.

COL. ALLAN C. BAKEWELL, who was recently elected president of the Sprague Electric Company, has long been identified with the electrical industry, and has won many friends through his executive ability and honorable business methods. He was vice-president and general manager of the old Interior Conduit & Insulation Company, which was absorbed by the Sprague Electric Company some years ago. Prior to his present advancement he was for three years second vice-president and general manager of the Sprague Company.

MR. N. A. CHRISTENSEN, who was superintendent of the Christensen Engineering Company from its organization, has resigned that position and is now consulting engineer to the company, which now markets only the Christensen air compressors used in connection with air brakes. Compressors for other service will be manufactured by the company, but for Mr. Christensen on his own account. Mr. Christensen has established offices in the Herman Building, Milwaukee, where communications relating to air compressors other than those for brake service should be addressed.

MR. RALPH W. POPE, secretary of the American Institute of Electrical Engineers, was married to Mrs. Katherine A. Durant, of Great Barrington, Mass., on Wednesday afternoon, October 1, at the bride's summer cottage, Ocean Grove, N. J. The ceremony was performed by the Rev. Mr. Longley, rector of Trinity Church, Asbury Park. There are few veteran electricians who are more popular than Mr. Pope. The American Electrician tenders congratulations to Mr. Pope and best wishes for good fortune and a long continuance of the useful life he has thus far enjoyed.

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TRADE PUBLICATIONS.

WATER-WHEEL GOVERNOR. Woodward Governor Company, Rockford, Ill.—A folder containing an illustration and description of the Woodward friction water-wheel governor.

THE NERNST LAMP. Electrical Material Company, Baltimore, Md.—A catalogue of standard size containing illustrations and prices of Nernst lamps, for which this company is a special agent in Baltimore.

THE FOUR TRACK NEWS. New York Central & Hudson River Railroad Co.—The October number of this very attractive publication, which contains a great deal of historical and descriptive matter of much interest.

EXHAUST FANS AND BLOWERS. Western Electric Company. Catalogue No. 3020, containing illustrations, descriptions and price-lists of ventilating fans and steel plate blowers direct-connected to electric motors.

THE "EXPRESS." Kellogg Switchboard & Supply Company, Chicago.—This is not a railway time table, but a nicely-executed pamphlet containing strong testimonial letters from users of the Kellogg "Express" telephone switchboard.

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TRIPLEX POWER PUMPS. The Goulds Manufacturing Company, Seneca Falls, N. Y.—A handsome catalogue devoted, as its title implies, to triplex pumps, which are built both single-acting and double-acting, and for every class of service involving the pumping of liquids.

TRAVELING LINK GRATES. Green Engineering Company, Chicago, Ill.—This is catalogue "C," containing an interesting argument on the subject of traveling grates, and a full description of the Green traveling link grate, together with illustrations of the various parts of the grate and a number of representative installations.

DAVIDSON PROPELLER FANS. Massachusetts Fan Company, Waltham, Mass.—A handsomely executed catalogue containing illustrations and data relating to the well-known Davidson propeller fan. The catalogue also contains information concerning sectional hot blast coils built by this company, together with some useful tables of data.

SOUVENIR. The Sterling Electrical Manufacturing Company, Warren, Ohio.—A very ornamental production, consisting of a heavy cardboard sheet, bearing an embossed reproduction, 7 ins. x 15½ ins., of the celebrated painting, "Diana's Chase." Beneath this picture is an engraving of the Sterling "Special," incandescent lamp and the motto: "The lamp that makes Warren famous."

ELECTRIC LOCOMOTIVES. Baldwin Locomotive Works, and the Westinghouse Electric & Manufacturing Company.—The 1902 catalogue issued jointly by these two companies, and containing a great deal of valuable information regarding electric locomotives. The catalogue is, of course, illustrated in the usual artistic style which characterizes publications of both of the interested companies.

PELTON WATER WHEELS. The Pelton Water Wheel Company, San Francisco and New York.—This is the ninth edition of the Pelton Company's catalogue and is a superb specimen of trade literature. The catalogue contains the usual quota of handsome illustrations, tables of hydraulic data, instructions for weir dam measurements, and descriptions of the water wheel governors used in connection with Pelton impulse wheels.

LINOTAPE. Mica Insulator Company, New York.—A small pamphlet setting forth the merits of a new insulating tape known as "Linotape" and consisting of a closely-woven linen tape coated with Empire oil on both sides. The tape is made in all widths from ¼-inch to 3 inches, and in .007, .01 and .016-inch thicknesses. Examination of a sample of this tape justifies the opinion that it should be a most excellent material for wrapping armature and field coils.

AIR COMPRESSOR. Chicago Pneumatic Tool Company, Chicago and New York.—A catalogue of standard size containing very complete detailed descriptions of the compressors built by this company. The catalogue is liberally illustrated and handsomely executed, all of the parts of the compressors being shown individually and fully described. Pneumatic hammers, air receivers, pneumatic drills, and other appurtenances used in connection with compressed air are also discussed.

DIRECT-CURRENT GENERATORS. Dick, Kerr & Co., Ltd., London.—This is one of the handsomest specimens of industrial publications that has ever come to the reviewer's desk. It is of semi-quarto size, and contains a complete description, excepting dimensions, of the direct-current, direct-driven generators built by the English Electric Manufacturing Company, Ltd., for whom Dick, Kerr & Co. are sole agents. The engravings are of the highest grade and heavy plate paper is used throughout the catalogue, which of course enhances the appearance of the illustrations. In the front and back are handsome photogravures showing the interiors of two power houses equipped with these machines and the power house and testing room of the factory.

BUSINESS NEWS.

JOHNSON & MORTON, Utica, N. Y., have discontinued their New York office and all business will hereafter be handled direct from the factory.

THE WESTERN ELECTRICAL SUPPLY COMPANY, St. Louis, has secured the agency for the new Nernst lamp, and is carrying a complete line of these lamps in stock.

THE LUNKENHEIMER COMPANY on October 25th opened its new Fairmount Works which occupy the entire block bounded by Beekman, Tremont, Longway and Waverly Avenues, Fairmount, Ohio.

WOOLSTON & BREW, New York, have secured the agency for the Brown Corliss Engine Company, of Corliss, Wis., for New York, Philadelphia and the New England States. Mr. Lee W. Woolston will continue to represent this company in the Eastern territory.

NOT THE INTERNATIONAL SCHOOLS.—We are requested by the International Correspondence Schools, of Scranton, to state that there is not and never has been any connection whatever between this establishment and another Scranton concern known as the Correspondence Institute of America.

PASS & SEYMOUR, INC., of Solvay, N. Y., whose New York City address has hitherto been 23 Dey Street, has moved the New York branch to more extensive premises at 34 Dey Street. D. Brewster Hall, formerly in charge of the sales department of the factory territory, is in charge of the new offices.

THE ELECTRIC STORAGE BATTERY COMPANY has acquired control of the Chloride Electric Storage Syndicate, Ltd., of England. This move enables the American company to sell batteries in foreign countries in competition with local manufacturers there, shipping the batteries, of course, from the English factory.

BRADLEY MANUFACTURING COMPANY, Pittsburg, Pa., manufacturer of the Willans high-speed engine, has secured through the Osborne Engineering Company, of Cleveland, a contract for three 533-h.p. triple-expansion engines to be direct-connected to Westinghouse alternators; one engine for driving a 75-kw. Westinghouse dynamo, and one for driving a 25-kw. exciter dynamo.

EUREKA ELECTRIC COLOR COMPANY, New York, desires to call attention of the trade to its coloring and frosting compounds for incandescent lamp globes. It is stated that these compounds will not chip, peel or blister. In addition to supplying compounds to those who wish to do their own coloring and frosting, the company frosts and colors lamps for its customers when desired.

VOUGHT-BERGER COMPANY, of La Crosse, Wis., has just moved into a new manufacturing plant, occupying three buildings, with a floor space of 20,000 square feet, making its factory one of the largest of its kind in the country. Mr. D. T. Foley, formerly superintendent and purchasing agent of Western Telephone Construction Company, has recently accepted a similar position in this company

BUNNELL COMPANIES CONSOLIDATED.—The Bunnell Telegraphic & Electric Company, of New York, has purchased the entire business and rights of J. H. Bunnell & Co., Inc., and the consolidated business will be conducted under the general supervision of Albert J. and Morris Wise. The Bunnell Company has a well-equipped factory at Milford, Conn., which was purchased from the National Electric Manufacturing Company, and also a fine plant in New York City.

SARGENT, CONANT & CO., Boston, have secured a contract for an extensive intercommunicating telephone system for the Boston Athletic Association. This firm, it may be remembered, recently completed a notable electrical equipment for Mr. Thomas W. Lawson's estate, which included a telephone system, fire alarm system, arc and incandescent lighting plant, etc., in which all of the wires were carried in underground ducts, and the plant was notably modern in other respects.

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THE ACORN ELECTRIC & MANUFACTURING COMPANY, New York, is the name of a new concern recently established in the manufacture of electrical and mechanical novelties. The company has a nicely-equipped machine shop and ample facilities for turning out specialties and model work and doing repair work. The officers of the new company are H. M. Sealy, president; W. H. Smith, general manager; and F. W. Smith, superintendent. The shops and headquarters are at 27 Thames Street.

SACHS ELECTRIC COMPANY is the name of a progressive concern recently organized in St. Louis for the purpose of handling electrical supplies. The company represents the manufacturers of Belden arc lamps, Femco (Franklin) incandescent lamps, Peerless transformers, Akron dynamos and motors, and many other representative establishments. Mr. Sachs was for over twelve years associated with the Western Electrical Supply Company, and is well and favorably known to the electrical fraternity throughout his section.

VAN DORN-ELLIOTT ELECTRIC COMPANY, Cleveland, Ohio, announces that it has made changes in its factory equipment which have resulted in greatly increased facilities for the manufacture of armature and field magnet coils, which department has heretofore been unequal to the demands made upon it. Mr. J. Norman Elliott has been appointed general superintendent of the factory, succeeding Mr. W. H. Elliott, who is no longer connected with the company. Mr. J. F. Thompson has been made foreman of the winding department.

WESTINGHOUSE, CHURCH, KERR & CO., New York, recently closed a contract with the Rhode Island Suburban Railway Company, Providence, R. I., for extensive additions to its power plant. The new apparatus will include a Westinghouse-Corliss cross-compound engine having a maximum capacity of 6600 horse-power, to be direct-connected to a 2500-kw. Westinghouse direct-current railway generator. A complete equipment of mechanical draft apparatus and Roney mechanical stokers for the boiler plant, which aggregates 5400 horse-power, will also be furnished.

THE ALBERGER CONDENSER COMPANY, New York, reports a gratifying trade in business of high vacuum condensing apparatus. Contracts were recently closed for complete equipments for the Hartford (Conn.) Street Railway Company; Binghamton (N. Y.) Light, Heat & Power Company; Port Huron (Mich.) Light & Power Company, and the Belt Light & Power Company. Alberger surface condensers with improved vacuum and circulating pumps will be supplied to the above plants, most of which have ordered the condensing apparatus for use in connection with Westinghouse steam turbines.

THE WARREN COMPANY, Chicago, manufacturer of Warren's pulley cover, is constantly receiving the most flattering testimonial letters regarding its product. In a recent letter from the Montezuma Electric Company, Aguascalientes, Mexico, ordering a can of pulley cover, the purchaser asked that the material be sent by express because the results from the use of a small sample can had been such that it was deemed unwise to run the risk of the delay of transit by freight. Another company in Mexico in ordering a second supply states that no trouble from hot boxes has been experienced since the pulley cover was put into service.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY reports an enormous demand for alternating current apparatus as well as a large business in direct current machinery. The Illinois Car & Equipment Company has recently purchased a full outfit of alternating current apparatus for its wood-working plant just outside of Chicago. The Goodall Worsted Company, of Sanford, Me., has bought a 400-kw. two-phase alternator which will supply power to Westinghouse motors throughout the works; and the Steel Storage & Elevator Construction Company has ordered a direct-current generator and equipment of direct-current motors for a large grain elevator to be erected for the Canadian Pacific Railway at Fort William, Ontario.

LIBERTY MANUFACTURING COMPANY, of Pittsburg, has purchased from the Sherwood Manufacturing Company, Buffalo, all patents, rights, title, interest, trade mark and good will appertaining to the manufacture of the boiler-tube cleaners of the turbine type. In future the Liberty Company will make and put on the market the "Niagara" tube cleaner, as well as its own standard "Chicago" tube cleaner. which has been the company's chief specialty for several years. This transaction, it is stated, gives the Liberty Company control of all basic patents on tube cleaners of the turbine type, and to meet the increased demands which are expected naturally to follow, the capacity of the company's plant will be greatly enlarged. The Liberty Company claims that the turbine principle is superior to any other for cleaning boiler and other tubes, and in justification of this claim points out that there are now over 8,000 cleaners of this type in successful use.

CROCKER-WHEELER COMPANY recently held at its works at Ampere, N. J., its annual Managers' Convention; on the first evening of the convention, a banquet was enjoyed by the delegates at the Engineers' Club, New York. Those present were the officers of the company, Dr. Schuyler S. Wheeler, Messrs. Gano S. Dunn, W. L. Brownell, Putnam A. Bates, C. N. Wheeler, and F. V. Henshaw; and the branch managers, Samuel Russell, Jr., Julian Roe, J. Hally Craig, Louis P. Hall, W. H. Wissing, Francis B. De Gress, Henry J. Sage, William A. Doble and Harold Lomas. At this dinner many interesting speeches were made by the branch office managers, who came from the various districts throughout the entire United States. During the evening, Mr. DeGress, of the New York office, having been in the service of the company longer than any of the other managers, presented to the general sales manager, Mr. Putnam A. Bates, a token of esteem from the branch-office managers and an acknowledgement of Mr. Bates' efforts in their behalf, to which Mr. Bates responded in his usual happy manner.

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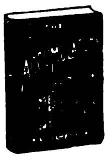

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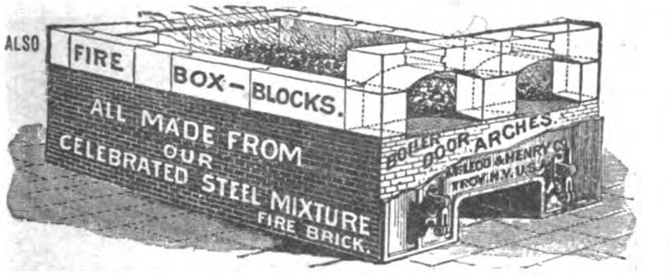
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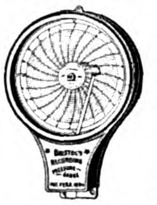

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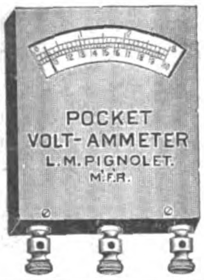
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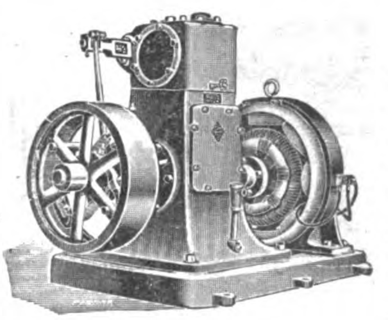

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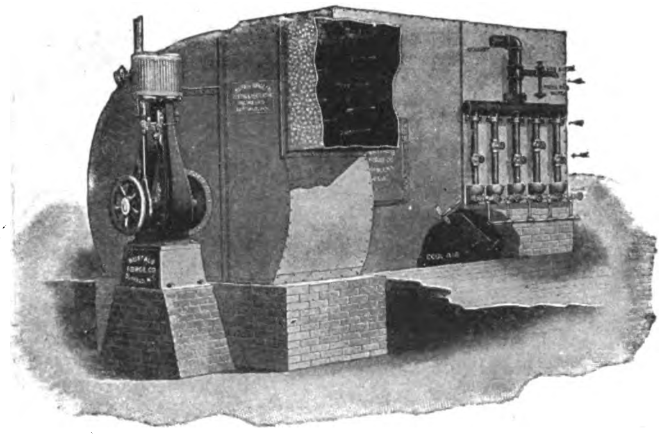

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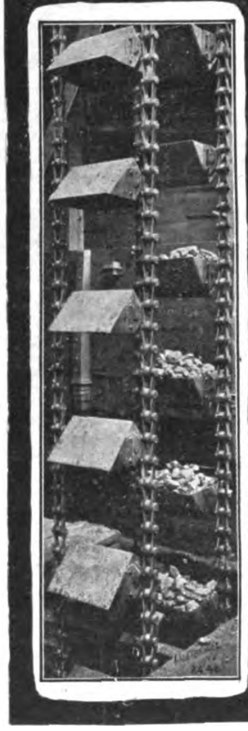

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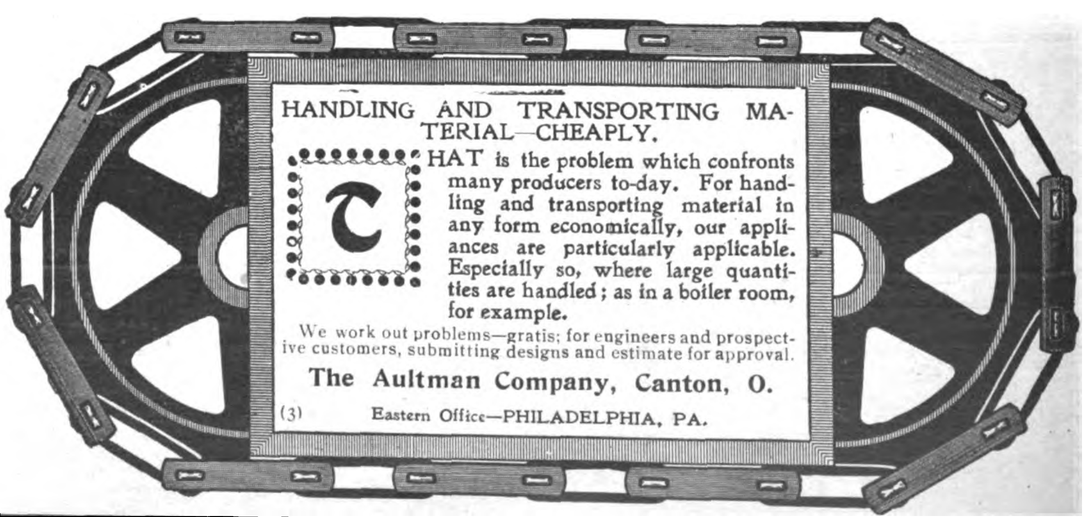

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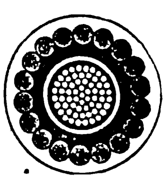

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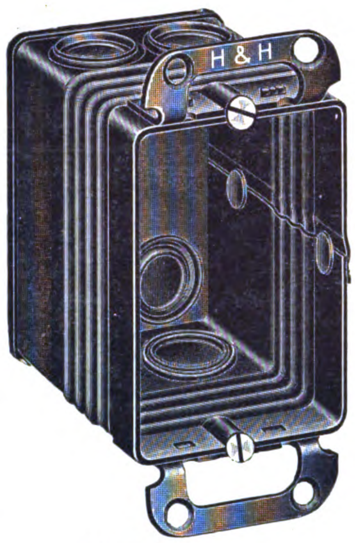

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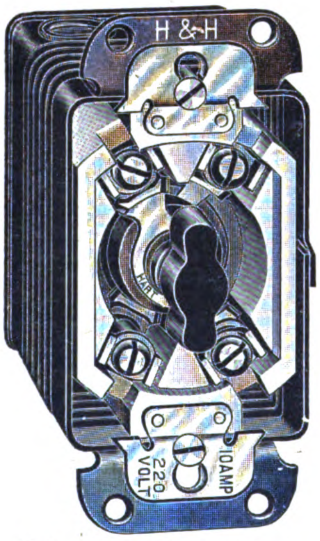
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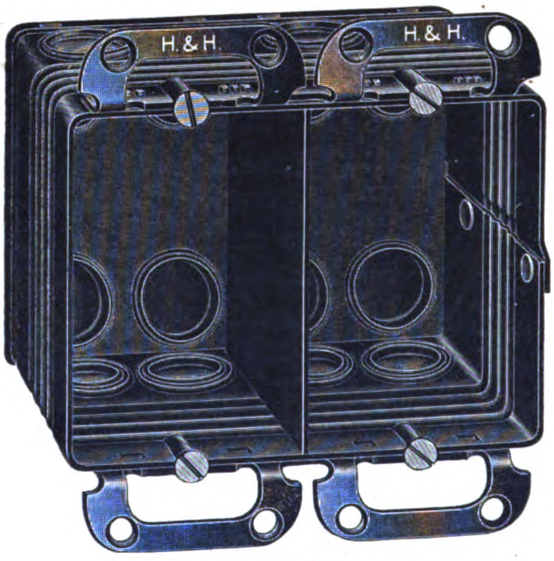

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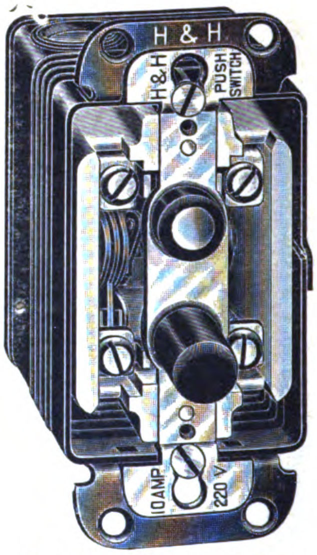
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FIRST LONG-DISTANCE, THIRD-RAIL INSTALLATION IN EUROPE.

POWER HOUSE AND SUB-STATIONS OF THE MILAN-PORTO CERESIO RAILWAY.

The first third-rail railway system to be installed in Europe for long-distance high-speed service was recently completed between Milan and Porto Ceresio, Italy, and will be ultimately extended to Laveno and Arona, when the total road length will be about 80 miles; the portion of the system now in operation comprises about 47 miles of road.

The power house is located at Tornavento, on the River Ticino, and contains eight three-phase alternators of 750 kilowatts capacity, coupled direct to the same number of turbine waterwheels, and three similar alternators direct-driven by tandem compound side-crank engines. The hydraulic power will not be available for some time to come, so the engines are now carrying the load; when the plant is complete they will be kept in reserve, the waterwheels normally taking the whole load.

The three engines are shown in Fig. 1, and are rated at 1500 to 2000 horse-power each, with steam at 150 lbs. pressure and running at 94 r. p. m. The high-pressure cylinder of each is 28.54 ins. in diameter, the low-pressure cylinder 47.24 ins. bore, and the stroke is 51.38 ins. (The unusual figures are due to the reduction of millimeters to inches and fractions.) Both cylinders are jacketed; the live steam passes through the high-pressure jacket before it enters the admission valve chamber, and the high-pressure exhaust passes similarly through the low-pressure cylinder jacket to the low-pressure admission valves.

Each cylinder has four valves, two admission and two exhaust, which are of a special poppet type with multiple seats. The object of this construction is to reduce the travel of the valve for a given amount of port opening, and to obtain quick closure without throttling the steam and thereby causing wire-drawing. The exhaust valves of both cylinders are operated by means of cams on a secondary shaft, and the admission valves of the low-pressure cylinder are operated in the same way. The cams are all adjustable for regulating the amount of lead and compression. The high-pressure admission valves are driven by eccentrics through a special trip device which is actuated by the governor to vary the cut-off. The governor is of the Porter high-speed type, driven from the secondary shaft by means of a spiral gear; it controls only the cut-off of the high-pressure cylinder, and is capable of varying this within the limit of six-tenths of the stroke.

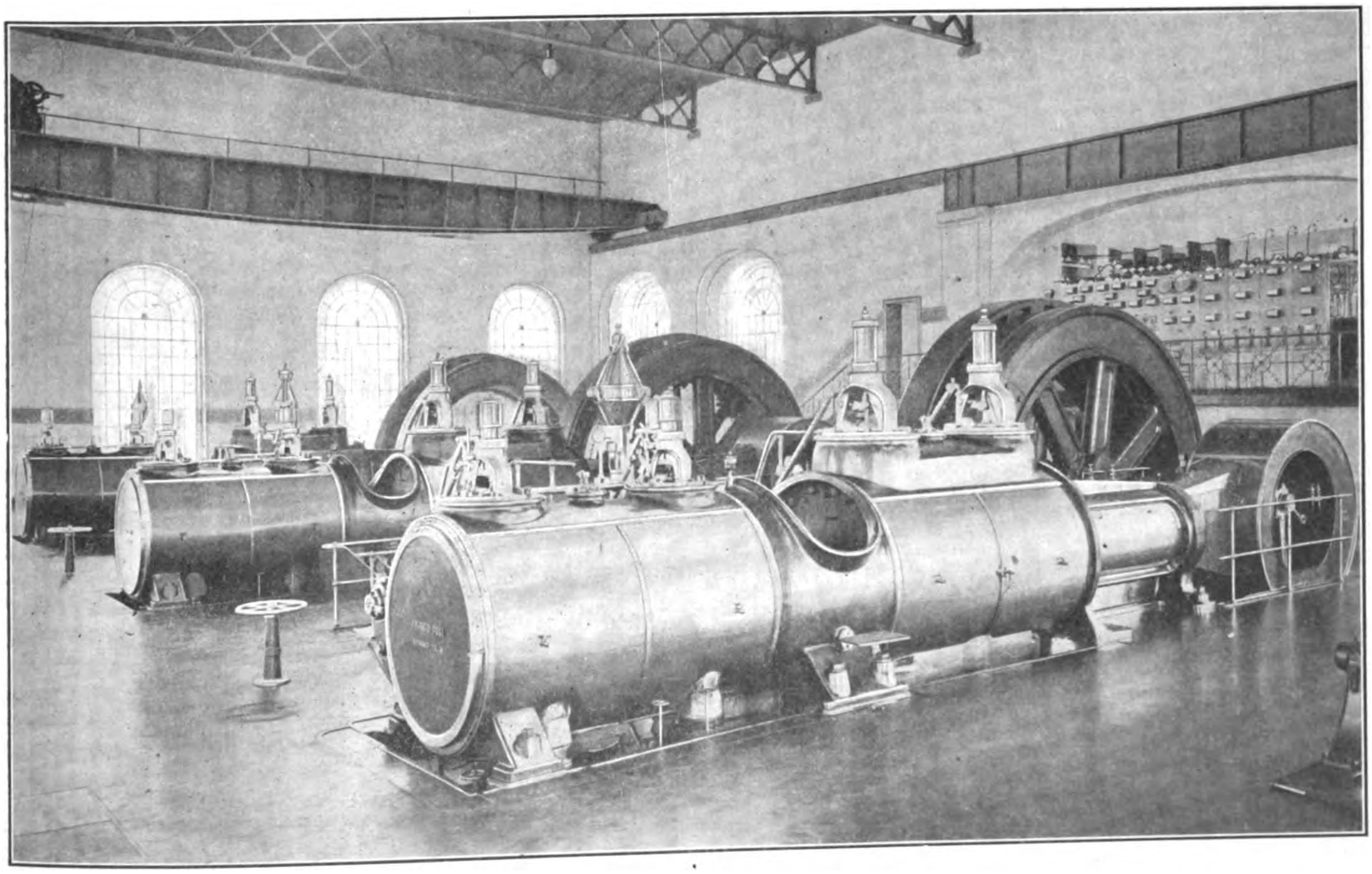


FIG. I.—STEAM-DRIVEN UNITS IN POWER-HOUSE OF THE MILAN-PORTO CERESIO RAILWAY.

Each of the steam pistons is made in a single piece; the piston rings are made in halves, and when it is necessary to renew them or set them out, the piston-rod is disconnected from the cross-head and the piston slid backward until the rings clear the end of the cylinder barrel. The rings are pressed outward against the wall of the cylinder by a number of flat springs located equidistant around the inner circumference of the rings.

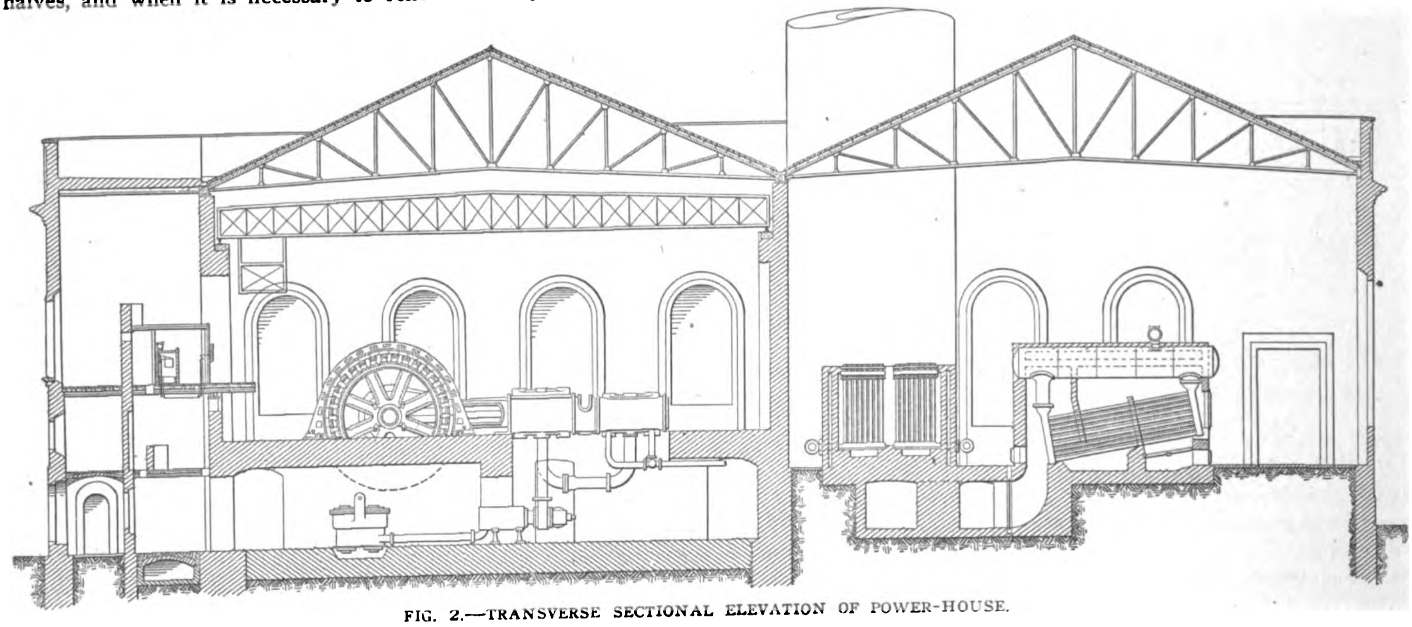


FIG. 2.—TRANSVERSE SECTIONAL ELEVATION OF POWER-HOUSE.

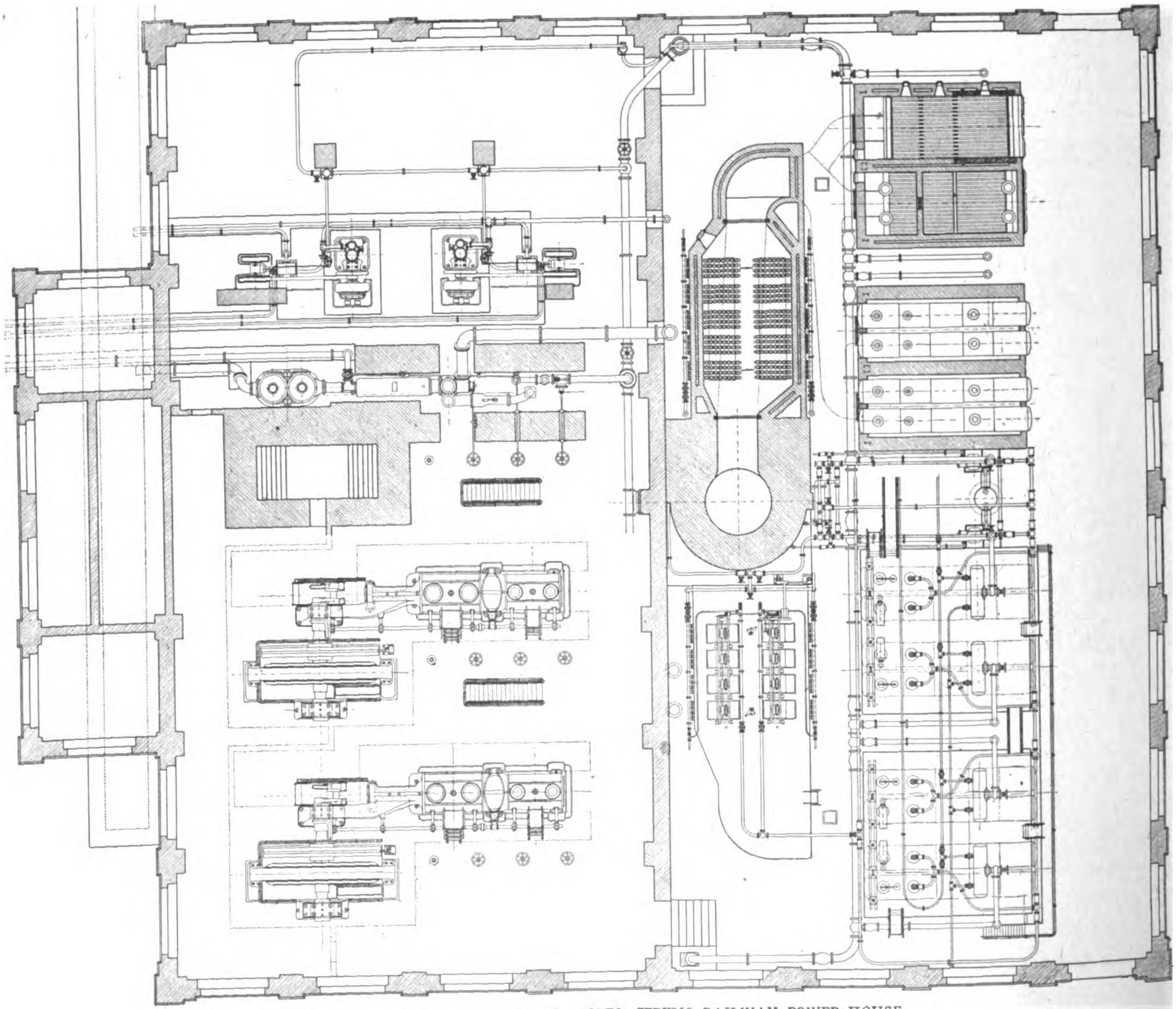
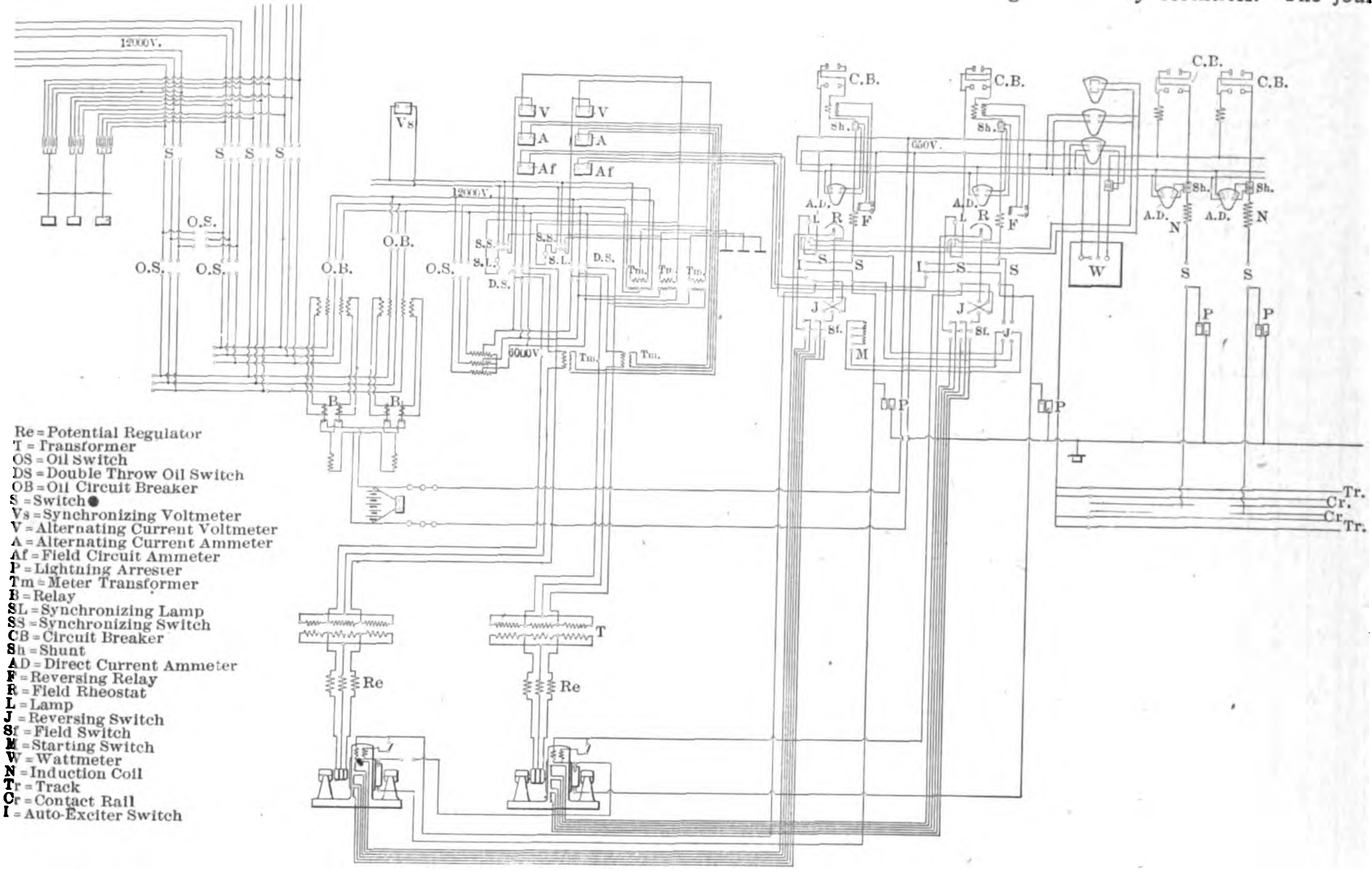


FIG. 3.—PLAIN VIEW OF MILAN—PORTO CERESIO RAILWAY POWER-HOUSE.

The frame of the engine is of the bayonet type with bored cross-head guides and is cast in one piece with the near crank-shaft bearing. This bearing, as well as the outboard bearing, is provided with a babbitt-lined bushing divided into four pieces, and adjustable by means of set-screws. The crank shaft is of Siemens-Martin steel and carries a flywheel 18 ft. in diameter, weighing 37 tons, together with the revolving member of the alternator—the field magnet.

As shown in Fig. 5 the air-pump is driven directly from the crank-pin of the engine through a connecting-rod and walking-beam. The pump is a duplex single-acting machine, without suction-valves, and is provided with extra large ports and passages in order to secure noiseless operation at high speed. Force feed lubrication is employed for the cylinders, oil being fed from a special pump, which draws the oil from the storage tank and delivers it to distributing pipes. This pump is mounted on the brace between the high-pressure and low-pressure cylinders, and is driven from the valve-gear shaft by eccentrics. The journals and guides are supplied with oil by gravity from a storage tank located about ten feet from the floor; after passing through the bearings and guides the oil is discharged through pipes to a filter lo-



12000V.
S
O.S.
O.B.
Vs
V
A
Af
S.S.
S.L.
D.S.
Tm
6600V.
B
T
Re
C.B.
Sh.
650V.
A.D.
R
F
L
I
J
St.
M
W
N
P
Tr.
Cr.
Re = Potential Regulator
T = Transformer
OS = Oil Switch
DS = Double Throw Oil Switch
OB = Oil Circuit Breaker
S = Switch●
Vs = Synchronizing Voltmeter
V = Alternating Current Voltmeter
A = Alternating Current Ammeter
Af = Field Circuit Ammeter
P = Lightning Arrester
Tm = Meter Transformer
B = Relay
SL = Synchronizing Lamp
SS = Synchronizing Switch
CB = Circuit Breaker
Sh = Shunt
AD = Direct Current Ammeter
F = Reversing Relay
R = Field Rheostat
L = Lamp
J = Reversing Switch
Sf = Field Switch
M = Starting Switch
W = Wattmeter
N = Induction Coil
Tr = Track
Cr = Contact Rail
I = Auto-Exciter Switch

FIG. 4.—SWITCHBOARD CONNECTIONS IN SUB-STATIONS.

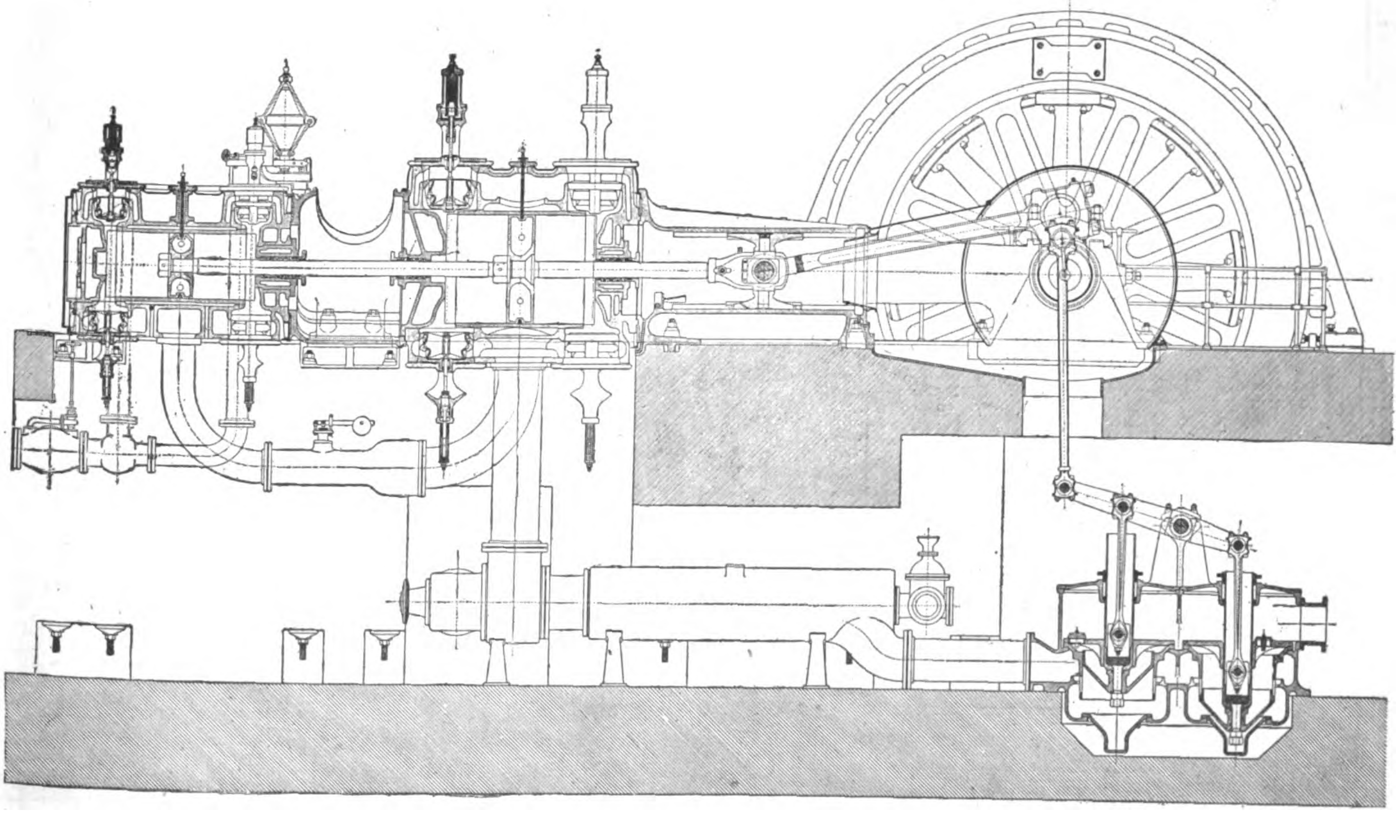
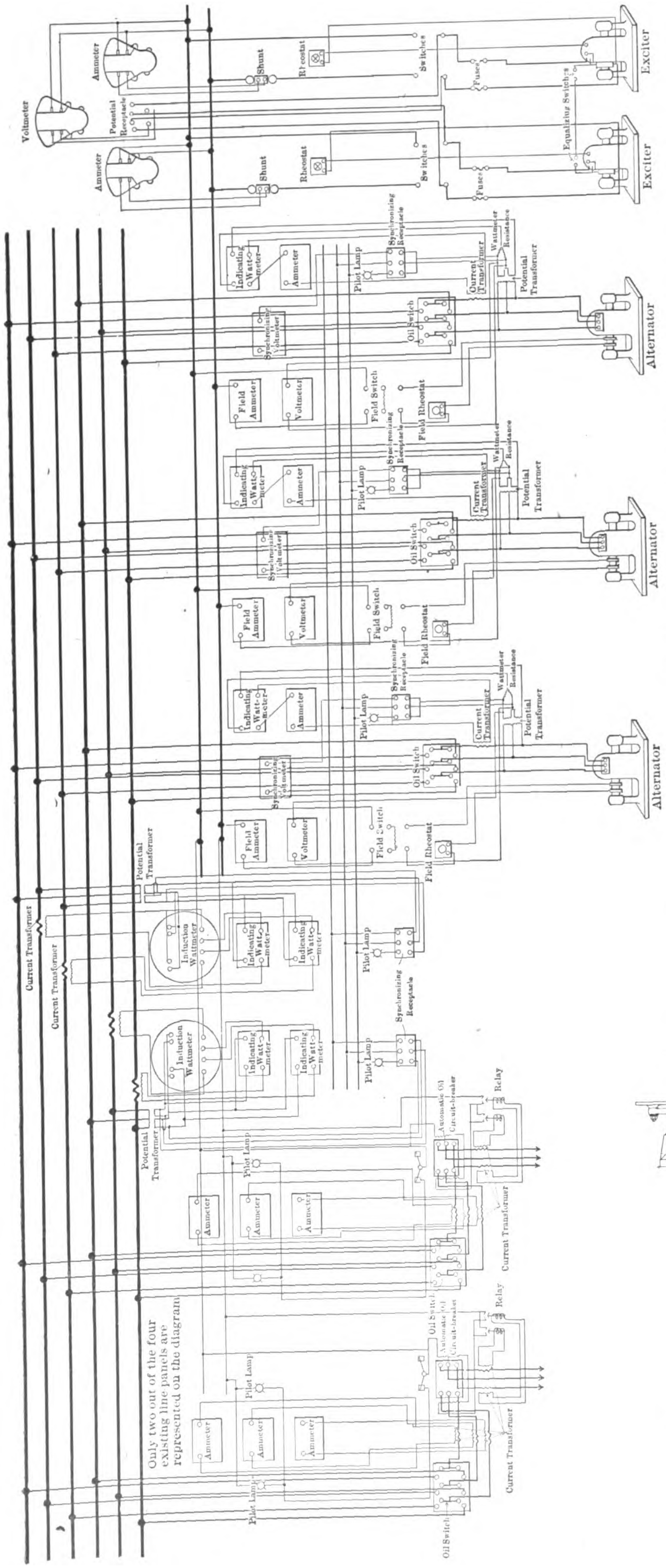


FIG. 5.—CROSS-SECTIONAL ELEVATION OF ENGINE AND AIR PUMP.


Voltmeter
Ammeter
Potential Receptacle
Shunt
Rheostat
Switches
Fuses
Equalizing Switches
Exciter
Exciter
Indicating Wattmeter
Synchronizing Receptacle
Wattmeter Resistance
Pilot Lamp
Current Transformer
Potential Transformer
Oil Switch
Synchronizing Voltmeter
Alternator
Field Ammeter
Field Switch
Field Rheostat
Alternator
Alternator
Induction Wattmeter
Automatic Oil Circuit-breaker
Relay

Only two out of the four existing line panels are represented on the diagram

FIG. 6.—DIAGRAM OF CONNECTIONS ON MAIN SWITCHBOARD.

cated in the basement, whence it is pumped back to the storage tank in the usual manner.

In addition to the main engines just mentioned, there are two vertical tandem-compound engines driving exciters. These have high-pressure cylinders 10.83 ins. in diameter, and low-pressure cylinders 15¾ ins. in diameter; the stroke is 11.81 ins. and the speed 270 r. p. m. Each engine is capable of developing from 85 to 125 brake horse-power with a steam pressure of 150 lbs. The two cylinders of each engine are cast in a single piece. They are not jacketed, but are thoroughly covered with a heat-insulating material. The valves are of the balanced piston type, located on a single rod, which is driven by a movable eccentric controlled by a shaft-governor to vary the cut-off up to one-half stroke in a similar manner to that employed in American practice.

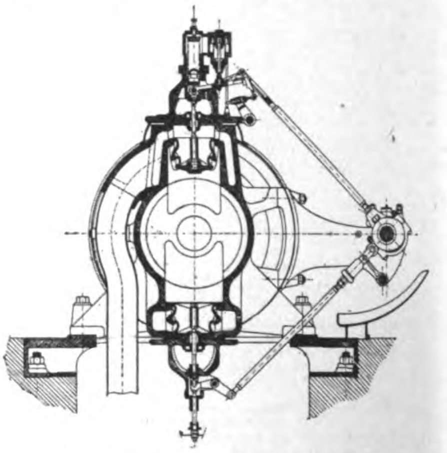


FIG. 7.—HIGH-PRESSURE VALVE GEAR.

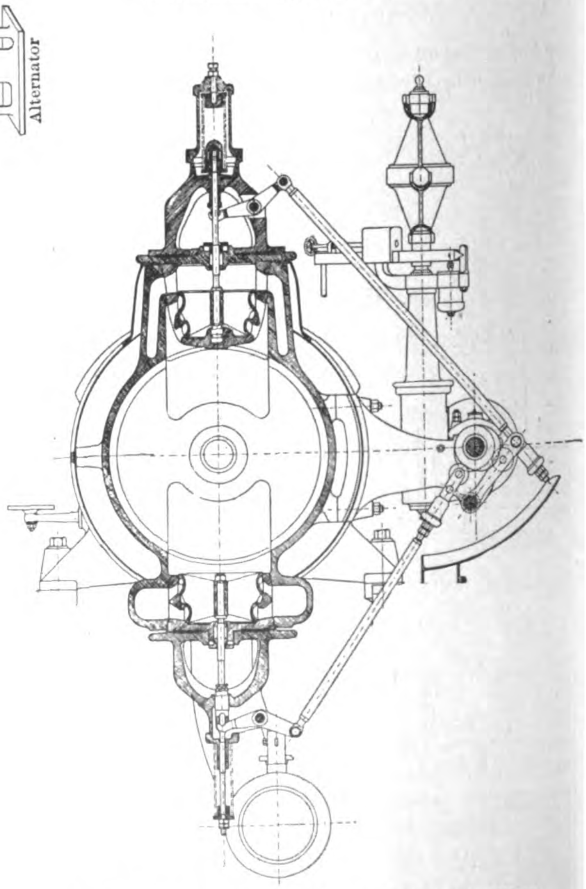


FIG. 8.—VALVE GEAR ON LOW-PRESSURE CYLINDER.

Steam is supplied to the engine plant by eight water-tube boilers, arranged in batteries of two, and connected by means of a common steam main. The water tubes are inclined, and opened at each end into chambers or headers having approximately rectangular cross-sections, and connecting with the drums by means of water-legs. Two economizers of ample surface and a jet-condenser system complete the essential features of the steam plant. The entire steam plant was built and installed by Franco Tosi, of Legnano.

The alternators are standard revolving field General Electric machines, having 32 field-magnet poles, and therefore operating at a frequency of 25 cycles. The e. m. f. generated is 13,000 volts, and the machines, while built for a continuous load of 750 kilowatts, are capable of standing 1400 kilowatts for a few moments at a time. The field-magnet spider, as the illustrations show, is mounted directly on the engine shaft. Exciting current is supplied by two six-pole dynamos of the standard electric lighting type, capable of an output of 75 kilowatts each at 125 volts.

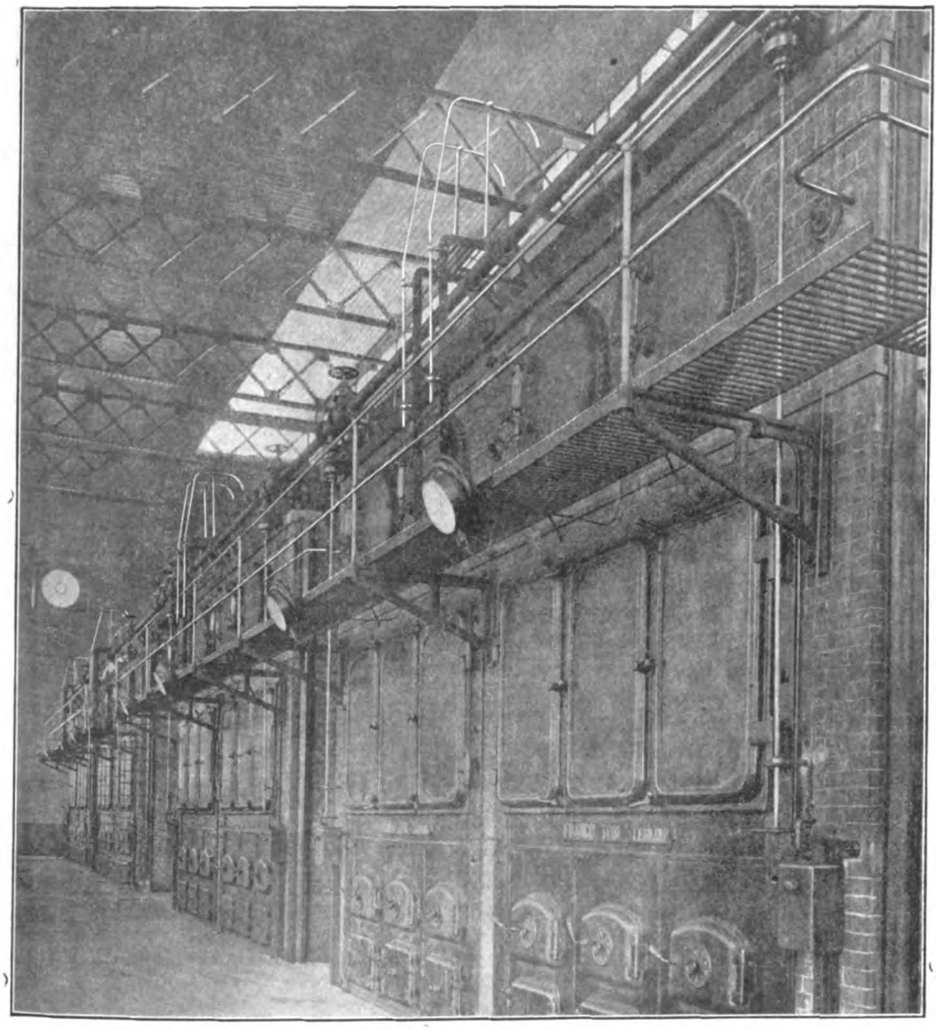


FIG. 9.—VIEW OF BOILER ROOM.

The switchboard is made up of nine panels, three of which, of course, are the alternator panels; the two exciters are controlled from a single panel, and there is the usual totalizing panel, leaving four line panels. The connections are shown by Fig. 6 and require no further elucidation.

There are five sub-stations located respectively at Gallarate, Parabiago, Musocco, Gazzada and Bisuschio. The sub-stations at the three first named towns are exactly alike. Each contains seven transformers of the air-blast type, six being operated ordinarily, and the other being held as a reserve; each transformer has a capacity of 180 kilowatts and reduces the line potential from 12,000 to 420 volts, at which latter potential current is delivered to the alternating-current brushes of two 500-kw. rotary converters. Only one converter is necessary during the ordinary loads, both being used during short periods when the load curve is highest. Each converter is supplied individually from three of the six regularly active transformers.

The sub-stations at Gazzada and Bisuschio contain each a single converter of 250 kilowatts capacity, supplied by the usual battery of air-blast transformers. As the load at these sub-stations is intermittent and very variable, they are provided in addition with a battery of accumulators having a capacity of 275 ampere-hours and a motor-driven booster. Fig. 4 herewith is a diagram of the switchboard connections of the three first named sub-stations, which have two rotary converters each.

COMPUTING THE STRENGTH OF TUBULAR BOILERS.

BY CHAS. L. HUBBARD.

While looking over an article in an engineering magazine a short time ago I was interested in a list of questions which the author claimed every engineer should be able to answer in regard to his plant. Among these it was asked, "What are the bursting and safe working pressures of your boiler?" In order to determine these in the case of a boiler which has been in use for some time one can only make the computations for a new boiler having the same thickness of shell, type of joint and method of bracing, and then assume a proper factor of safety depending upon the general condition of the boiler and length of time it has been in use.

In calculating the resistance of a boiler to internal pressure, first take the case of a plain hollow cylinder without joints. Taking a section of the cylinder one inch in length, if S = stress or tension per square inch in shell plate; p = steam pressure per square inch in cylinder; d = diameter of cylinder in inches, and t = thickness of shell, in inches, the following equations express the relations between these four factors:

$$S = \frac{d \times p}{2t} \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$t = \frac{d \times p}{2S} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

$$p = \frac{2S \times t}{d} \quad \ldots\ldots\ldots\ldots (3)$$

and

$$d = \frac{2S \times t}{p} \quad \ldots\ldots\ldots\ldots (4)$$

For example, suppose a cylinder 60 ins. in diameter is made of mild steel ½ in. in thickness, having a tensile strength of 60,000 lbs. per square inch. What will be the probable bursting pressure in pounds per square inch? Equation (3) gives

$$p = \frac{2 \times 60{,}000 \times .5}{60} = 1000 \text{ lbs.}$$

If a factor of safety of 6 were allowed the working pressure would be $1000 \div 6 = 166$ lbs.

In the foregoing illustration it was assumed that the shell of the cylinder was made up of a single plate, without joints. In practice, however, it would necessarily contain one or more riveted seams, and the strength of a longitudinal riveted seam is always less than that of the solid plate. Therefore, in order to make the formulas suitable for practical use they must contain a factor to represent the efficiency of the special form of joint in use. As it is nearly always the working pressure instead of the bursting pressure that one wishes to ascertain, the formulas may be made still more practical by introducing the factor of safety to be used.

If S_1 = the ultimate or breaking stress of the shell per square inch of section; F = the factor of safety, and E = the efficiency of the joint, then the formulas will take the form

$$t = \frac{d \times p \times F}{2 S_1 \times E} \ldots\ldots\ldots\ldots\ldots (5)$$

$$p = \frac{2 S_1 \times t \times E}{d \times F} \ldots\ldots\ldots\ldots (6)$$

and

$$d = \frac{2 S_1 \times t \times E}{p \times F} \ldots\ldots\ldots\ldots (7)$$

The following values may be taken as the average efficiencies of the different types of riveted joints:

Double riveted lap-joint......70%
Triple " " 75%
Double riveted butt-joint.....80%
Triple " " 86%

Example:—What is the safe working pressure for a boiler 54 ins. in diameter, having shell plates of mild steel ⅜ in. thick, with triple-riveted lap-joints, allowing a factor of safety of 5? Substituting in formula (6),

$$p = \frac{2 \times 60{,}000 \times .375 \times .75}{54 \times 5} = 124 \text{ lbs.}$$

Thus far only the longitudinal seams have been considered. The girth seams, of course, are also subjected to a stress, but in the direction lengthwise of the boiler. The total pressure upon the head of the cylinder is equal to its area in square inches multiplied by the internal pressure per square inch; this equals $\pi d^2 \times p \div 4$. This pressure must be resisted by a section of metal having an area equal to the circumference of the shell multiplied by its thickness, or $\pi \times d \times t$; d being the diameter and t the thickness of the shell, as before. If the stress per square inch in the shell due to end pressure be represented by S_2, then

$$S_2 = \frac{\pi \times d^2 \times p}{4 \times \pi \times d \times t},$$

which reduces to

$$S_2 = \frac{d \times p}{4t} \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Now, according to equation (1) for longitudinal seams,

$$S = \frac{d \times p}{2t},$$

so that S_2, or the stress due to the end pressure, is just one-half that due to the radial pressure; therefore, the girth seams need be only one-half as strong as the transverse seams.

TABLE I.

DOUBLE RIVETED LAP JOINTS.

Thickness of Plate.	Diameter of Rivets.	Pitch of Rivets.	Vertical or Transverse Pitch.	Edge of Plate to Center of Rivets.	Pitch of Rivets, Girth Seam.	Edge of Plate to Center of Rivets, Girth Seam.	Strength of Joint.
¼	11/16	2⅞	1 15/16	1⅛	2 1/16	1⅛	74%
5/16	¾	2⅞	1 15/16	1 7/32	2⅛	1 7/32	72%
⅜	⅞	3¼	2 3/16	1 13/32	2⅜	1 13/32	70%
7/16	15/16	3¼	2 3/16	1½	2 7/16	1½	70%
½	1	3 [illegible]/100	2 3/10	1 19/32	2½	1 19/32	68%

TRIPLE RIVETED LAP JOINTS.

Thickness of Plate.	Diameter of Rivets.	Pitch of Rivets.	Vertical or Transverse Pitch.	Edge of Plate to Center of Rivets.	Pitch of Rivets, Girth Seam.	Edge of Plate to Center of Rivets, Girth Seam.	Strength of Joint.
¼	⅝	3	2	1 1/32	2 1/16	1 1/32	77%
5/16	11/16	3⅛	2⅛	1⅛	2⅛	1⅛	76%
⅜	¾	3¼	2 3/16	1 7/32	2⅛	1 7/32	75%
7/16	⅞	3¾	2½	1 13/32	2⅜	1 13/32	75%
½	15/16	3 15/16	2⅝	1½	2½	1½	75%

TABLE II.

DOUBLE RIVETED BUTT JOINTS.

Thickness of Plate.	Diameter of Rivets.	Pitch of Rivets, in Inches.	Width of Outside Butt Strap.	Width of Inside Butt Strap.	Thickness of Covering Straps.	Vertical or Transverse Pitch.	Edge of Butt Strap to Center Rivets.	Pitch of Rivets, Girth Seam.	Edge of Plate to Center of Rivets, Girth Seam.	Strength of Joint.
5/16	11/16	2¾x4½	4½	9	¼	2¼	1⅛	2⅛	1⅛	83%
⅜	¾	2⅜x4¾	4⅞	9⅞	5/16	2 7/16	1¼	2⅛	1 7/32	82.9%
7/16	13/16	2 15/32x4 15/16	5¼	10½	⅜	2⅝	1 15/16	2¼	1 7/32	82%
½	⅞	2 9/16x5⅛	5⅝	11¼	7/16	2 13/16	1 13/32	2¼	1 13/32	80%

TRIPLE RIVETED BUTT JOINTS.

Thickness of Plate.	Diameter of Rivets.	Pitch of Rivets, in Inches.	Width of Outside Butt Strap.	Width of Inside Butt Strap.	Thickness of Covering Straps.	Vertical or Transverse Pitch.	Edge of Butt Strap to Center Rivets.	Pitch of Rivets, Girth Seam.	Edge of Plate to Center of Rivets, Girth Seam.	Strength of Joint.
5/16	11/16	3⅛x6¼	9¼	14	¼	2⅛	1¼	2 1/16	1⅛	88%
⅜	¾	3¼x6½	9¼	14¼	5/16	2 3/16	1 7/32	2⅛	1 7/32	87.5%
7/16	⅞	3⅜x6¾	10⅛	15⅝	⅜	2¼	1 13/32	2 7/16	1½	86%
½	15/16	3½x7½	11	16¾	7/16	2⅜	1 17/32	2½	1½	86.6%

A single-riveted lap-joint of usual dimensions has an efficiency of 50 per cent. or over, so that in all girth seams the boiler is as strong relatively as the solid plate is in sections parallel with the axis of the cylinder. Tables I and II herewith give the different dimensions for the common forms of riveted joints as recommended by the Hartford Steam Boiler Inspection and Insurance Company, and will be found useful for comparison in the case of old boilers or in the design of new work. Figs. 1, 2, 3 and 4 show the different types of joints.

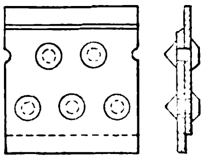


FIG. 1.

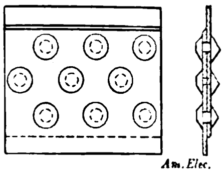


FIG. 2.

Having checked the thickness of shell and the riveted seams, the next step is to make a careful examination of the method of bracing or staying the boiler heads. There are three general methods in common use: the "through brace," the crow-foot brace," and the "solid brace." Through bracing consists of rods passing through the entire length of the boiler with heavy nuts and washers at the ends on the outside and check nuts on the inside. Stiffening pieces of channel or angle iron are riveted to the heads to support them. Fig. 5 shows the general arrangement of the channel or angle irons and the ends of the rods or braces, together with a section of the angles and head. The upper bar in this case consists of a channel iron with an angle riveted to its upper flange to give greater strength, while the lower bar is made up of two angles riveted to the head, as shown.

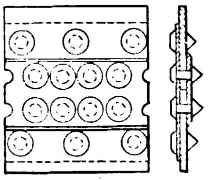


FIG. 3.

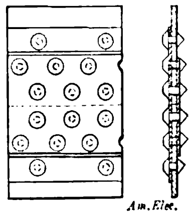


FIG. 4.

Where angles are used instead of channel iron, it is necessary to countersink slightly around the holes for the braces, in order to give a solid bearing for the washer which is placed under the check nut.

The outside washer is sometimes made of copper, slightly cup-shaped on the under side in order to make a tight joint around the edge. If cast-iron washers are used they should be embedded in red lead. When channel bars will give the required strength they are preferable to angles for stiffening pieces, but for high pressures the standard weights will in many cases be found too light, and resort must be had to angle irons, of which there is a great variety to choose from. In this form of bracing the channel bars act as beams carrying the load due to the pull on the rivets, and the beams in turn are supported by the rods.

Table III will be found useful in checking up the sizes of braces and stiffening bars in boilers already in use. The stiffening bars are usually called the "channels," whatever their make-up. The small piece riveted to the upper channel is called the "angle." In calculating the sizes of braces, allowance has been made for a reasonable amount of corrosion. The body of the brace inside of the boiler shell should be measured, and an examination should be made to see that the ends have been upset so that the diameter at the root of the thread is equal to that of the body. The table is for 100 lbs. working pressure.

TABLE III.

Dia. of Boiler.	Number of Braces.	Dia. of Braces.	Channel Bars.	Angle.
42	4	1¼	Two 2½x2x½ angles, short flange riveted to head.	2¼x2¼x¼
48	4	1½	Two 2½x2½x½. Angles.	2½x2½x½
54	5	1⅝	6x2.39x.52. Channel	3x2½x9/16, long flange riveted to head.
60	5	1½	6x2.39x5.2. Channel.	3x3x⅜
66	5	1¾	7x2.67x.57. Channel.	3½x3x13/16 long flange riveted to head.
72	5	1¾	Two 3½x2½x11/16 angles, long flange riveted to head.	3½x3x11/16, long flange riveted to head.

In crow-foot bracing, the supported points are usually attached to a forging known as a crow-foot (see *A*, *A*, Fig. 6). A diagonal stay with a forked head and pin connects each crow-foot with the boiler shell, to which it is fastened with two or more rivets. A crow-foot joined to the boiler head with four rivets, as in Fig. 7, is called a double crow-foot; when only two rivets are used, as in Fig. 8, it is called a single crow-foot. As the crow-foot and joining rods are forgings, they are necessarily made of wrought iron and should not carry a load of more than 5000 lbs. per square inch of section, measured at the weakest point.

Table IV gives the size of pin and two rivets to be used with round iron stays of different diameters. The pin and rivets are assumed to be of steel, and are of such size as to be equal in strength to the body of the brace.

TABLE IV.

Dia. of Brace.	Dia. of Pin.	Dia. of Rivets.
⅞	¾	¾
1	¾	¾
1⅛	⅞	⅞

A common form of solid steel brace is shown in Fig. 9. These are coming into use quite rapidly and are replacing the crow-foot brace. This form being made in one piece, without welds, can be made of steel, and therefore has a much greater tensile strength per square inch of section than the crow-foot. A safe working load of 10,000 lbs. per square inch may be carried, as against 5000 with a welded iron brace.

The surface to be supported by the braces is evidently that portion of the head above the tubes. In practice, however, it is not necessary to put in braces enough to sustain the whole of this area; for the reason that when the head is flanged and riveted to the shell, a portion of it becomes stiff enough to carry the pressure without depending upon the braces. The distance that thus becomes self-supporting may be determined by the formula

$$D = \frac{4484 \times T}{10 \times p} + .5 \ldots\ldots\ldots\ldots (9),$$

in which D = the distance inward from the shell, as indicated in Fig. 10; T = the thickness of the head, and p = the steam pressure per square inch.

When a boiler head has several rows of tubes expanded into it, a portion of it for a short distance above the upper row of tubes is sufficiently well stayed by the tubes, and it is usually safe to call this distance two-thirds of that determined by the formula. This leaves an area of the shape and location indicated by the shaded part in Fig. 11 to be stayed by the braces. Multiplying this area in square inches by the steam pressure carried gives the total pressure, of course, and dividing this by the number of braces will give the tension on each brace, provided they are properly

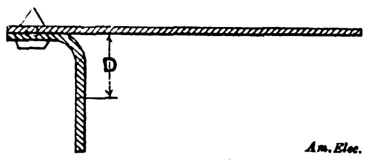


FIG. 10.

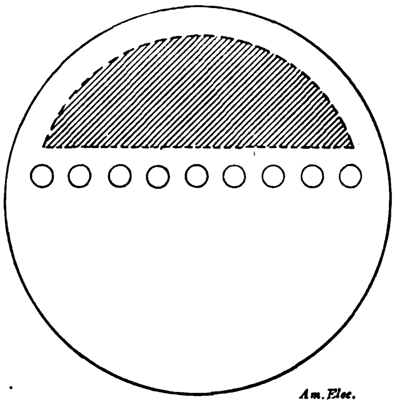


FIG. 11.

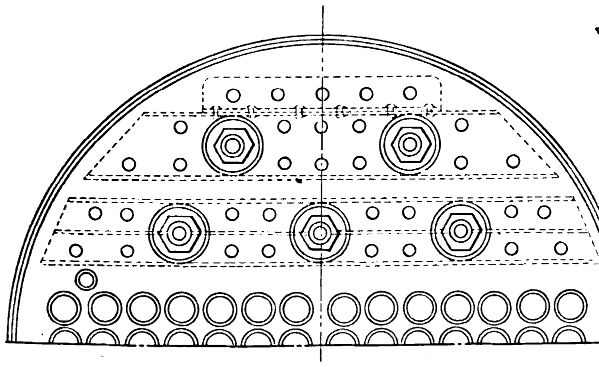
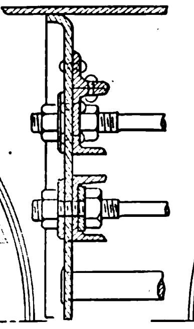


FIG. 5.



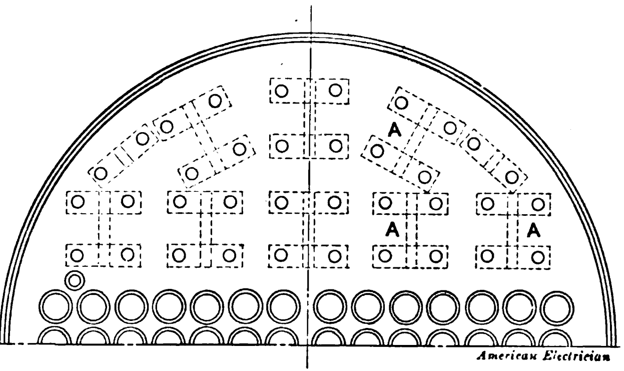


FIG 6.

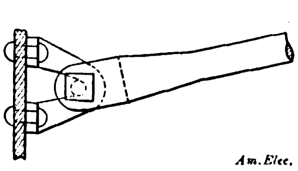


FIG. 7.

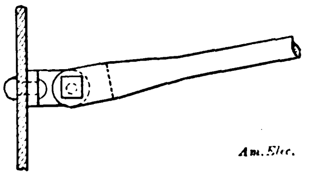


FIG. 8.

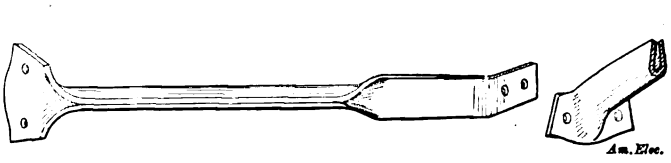


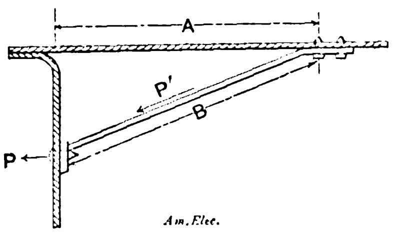
FIG. 9.

spaced. Dividing the load on a single brace by its sectional area at the weakest part will give the tension per square inch that it is carrying practically. This should not exceed 5000 lbs. for welded wrought iron, 7500 lbs. for wrought iron without welded joints, and 10,000 lbs. for steel.

The angle which the brace makes with the shell affects the tension to a greater or less extent, depending upon the magnitude of the angle. In Fig. 12 the pull *P'* in the direction of the axis of the brace is greater than the force *P* acting in a line perpendicular to the head of the boiler, so that after determining the load carried by each brace due to the steam pressure on the boiler head, it must be multiplied by a factor which depends upon the angle at which the brace is set, in order to find the actual tension in the body of the brace, as indicated by *P'*. It is not necessary, however, to know the angle; representing the length of the brace, rivet to rivet, by *B* and the distance from the boiler head to the brace rivets in the shell, by *A*, as in Fig. 12, the formula

$$\frac{B}{A} \times P = P' \text{.................} (10)$$

will give the actual tension sustained by the brace.



FIT. 12.

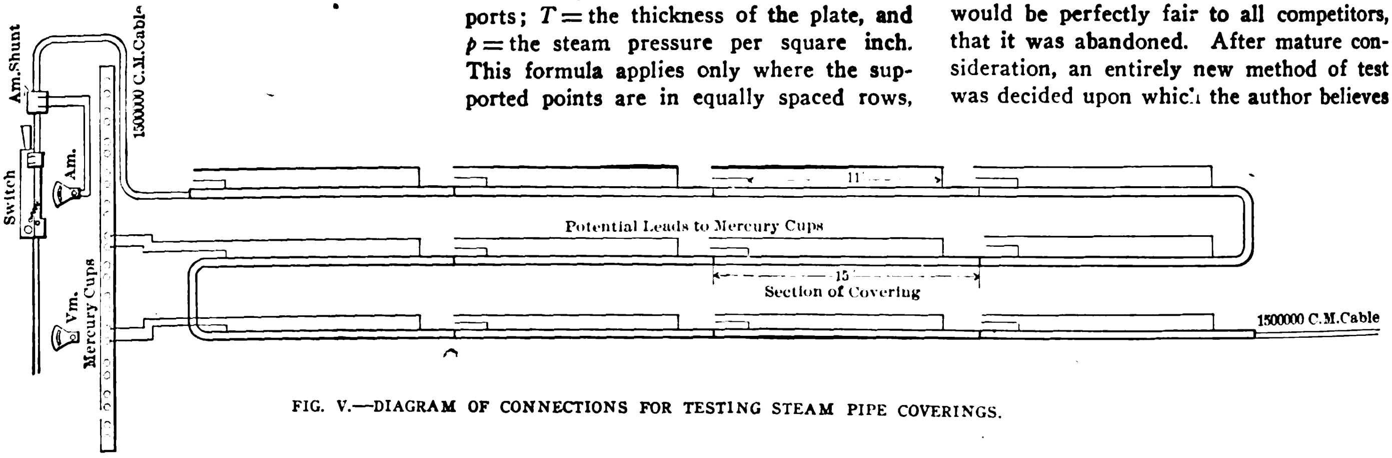


FIG. V.—DIAGRAM OF CONNECTIONS FOR TESTING STEAM PIPE COVERINGS.

As a matter of convenience, the rule is given here for computing the area of the segment of a circle, which is necessary in finding the pressure upon the shaded portion shown in Fig. 11. First compute the area of the sector *o-a-b-c* (Fig. 13), which is equal to the distance, *a-b-c*, measured around the shell, multiplied by one-half the radius *o-a*. Next compute the area of the triangle *o-a-e-c*, which is equal to *a-e* multiplied by *o-e*, and subtract this from the area of the sector first found. The result will be the area of the segment.

The rivets which fasten the brace to the boiler head are in tension, and should safely carry a load of 7500 lbs. per square inch. The rivets fastening the brace to the shell are subjected to a shearing strain, and should not carry more than 6400 lbs. per square inch.

Having taken up the strength of the braces and rivets, the next step is to determine if the braces are placed near enough together to properly support the head. The stresses in flat surfaces supported at regular intervals may be computed by the formula

$$S_1 = \frac{2j^2}{9T^2p} \text{..................} (11),$$

in which j = the distance between supports; T = the thickness of the plate, and p = the steam pressure per square inch. This formula applies only where the supported points are in equally spaced rows, both vertically and horizontally. When the rows are not equally spaced, the greatest distance between supports may be taken for the value of j in the formula, which will give a safe result in all cases. The points of support are the rivets which fasten the head to the brace, crow-foot or channel bar, as the case may be. The tension, S_1, should not exceed about 6000 lbs. for steel or 4500 for wrought iron.

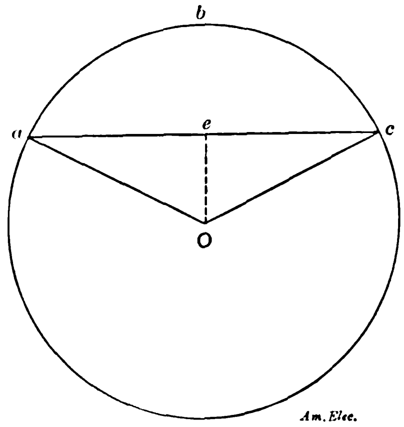


FIG. 13.

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Hints on Cooling a Boiler.—Never open the fire doors to cool your boiler. Close the ash-pit doors and open the smoke box doors in case you get too much steam, as opening the fire door causes too much contraction by the cold air cooling the furnace. It would be better to allow steam to blow off from the safety valve, which will not in any way injure the boiler.

STEAM PIPE COVERING AND ITS RELATION TO STATION ECONOMY.

BY H. G. STOTT.

An investigation of the best engineering practice in covering high pressure steam pipes disclosed that fact that although several tests of the efficiency of different types of covering had been made, nothing had been done towards determining the most economical thickness and the most efficient method of applying the covering, when taking into consideration the resultant station economy.

Before awarding a contract for covering the steam pipes in the Manhattan Railway Company's power house, a careful investigation and test of different types and thicknesses of covering was made under the author's direction. In order to get the necessary data it was decided to carry out a complete test of the various types of covering on the market, and also to investigate the effect of varying the thickness of the insulating wall.

The usual method of test previously used was the condensation method, but this method is subject to so many errors due to variation in the quality of the steam supplied, the relative positions of the different samples under test in regard to the distance from the boiler, and the exact measurement of the surface exposed, etc., not to mention the tediousness in getting results, which would be perfectly fair to all competitors, that it was abandoned. After mature consideration, an entirely new method of test was decided upon which the author believes meets every requirement of accuracy and perfect fairness to all, whilst covering a wide range of temperatures, and so giving many points which, when plotted in curves, would tend not only to show the efficiency of a covering, but at the same time to indicate any errors in taking readings.

The method adopted is illustrated by Fig. 1, and consisted in coupling up about 200 feet of 2-in. iron pipe and mounting the same on wooden horses about three and one-half feet from the floor, the three lines of pipe being approximately four feet apart and four feet from the nearest wall, in order to avoid any errors due to heat convection and radiation. Sections 15 feet in length were marked off on the straight portions of the pipe, and arranged so as not to include any pipe couplings or bends; two feet from each end of each section heavy potential wires were soldered on to the pipe, and at the extreme ends of the pipe 1,500,000 circ. mil copper insulated cables were soldered on, the openings in the pipe having been previously closed by means of a standard coupling and plug. One of these cables ran direct to one terminal of a 250-kw. 250-volt direct-driven exciter, which was devoted solely to furnishing current for the test, and which could have its voltage varied within wide limits so as to furnish any current up to 1,500 amperes. The cable connected to the other end of the pipe was then connected to three ammeter shunts in series, in order to enable the readings to be easily checked, after which it was carried through a circuit-breaker and switch to the other exciter terminal. The pipe covering test was carried on in a vault in which there was no source of heat and no possibility of draughts of air, and arranged so that the section in which the test was being carried on could be locked up in order to prevent interference with the test.

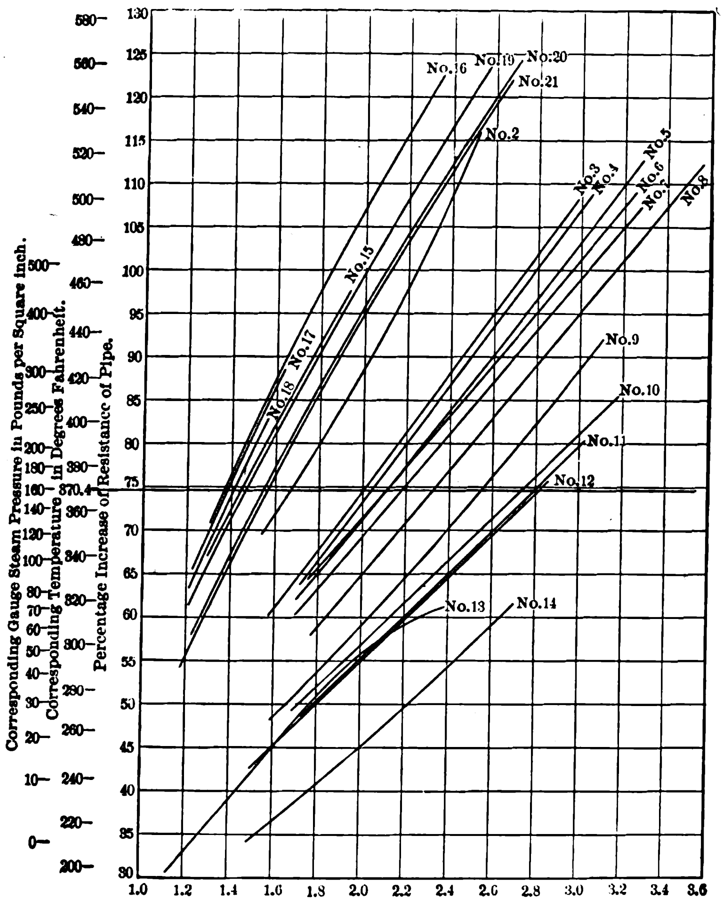

FIG. 2.—CURVES SHOWING LOSSES WITH VARIOUS STEAM-PIPE COVERINGS.

Invitations for bids were sent to all the principal pipe covering manufacturers and jobbers, specifying that each one would be expected to cover one or more sections of the 2-in. pipe for a competitive test, and that samples from the successful bidders' covering would be analyzed in the company's chemical laboratory, and no covering accepted which departed more than 3 per cent. from this analysis.

A special Weston milli-voltmeter was ordered, with which readings were taken from the potential wires, the latter all being brought to mercury cups on a testing table near which the ammeters were also located.

Preliminary tests were made with a small current in order to establish the individual resistance of the 11-ft. sections between the potential wires; this current was then gradually increased and more readings taken, together with temperature readings from thermometers having their bulbs in contact with the pipe at an angle of about 30 degrees, the stems projecting through the covering. From these readings a coefficient of .4649 per cent. increase of resistance per degree Centigrade was determined, and afterwards used in determining temperatures of the various sections. At first it was thought that temperatures could be determined with sufficient accuracy by the thermometers, instead as above described in the center of each section covered, but, after a preliminary series of readings this was abandoned as inaccurate, owing, no doubt, to the variable contact made by the bulb on the bare pipe. All temperatures were, therefore, calculated by the resistance method.

Current sufficient to heat the pipe to approximately 370 degrees Fahr. (corresponding to a steam gauge pressure of 160 lbs.) was kept on for three days continuously in order to dry out the various coverings, after which they were allowed to cool off to the air temperatures before starting the test. The temperature of the room was kept between 27 C., and 31 C. during the entire test; each section had about 600 readings taken, and where any doubt existed in reference to readings, the entire series was gone over a second and third time with the gratifying result that it was conclusively shown that the test could be repeated with a variation of results not exceeding 2 per cent.

The method of test was to put a current of sufficient quantity through the pipe to heat it to say 220 degrees Fahr., and keep this current on for a sufficient time to enable all sections to maintain a constant temperature (this period was found to be about ten hours) when readings of the milli-voltmeter were taken on each section with simultaneous ammeter readings. As all the sections were in series electrically, the current was, of course, the same, so that no error could arise due to variation of current.

The object of leaving two feet at the end of each section, or four feet between potential wires, was to avoid any error due to conduction of heat through the pipe. Tests were made to prove the efficiency of this precaution, and showed that no perceptible error was introduced.

A constant temperature having been obtained, it is evident that the watts lost in each section give an exact measure of the energy lost in maintaining a constant temperature, and from the watts lost the heat units are readily calculated. The diagram, Fig. 2, shows the result of the test values being reduced to loss in B. T. U. per square foot of pipe surface at various temperatures in the curves, and at a temperature corresponding to steam at 160 pounds pressure in the table. Table I gives the summary.

After a series of readings had been completed, the current was raised sufficiently to give approximately 50 degrees Fahr. rise in the least efficient covering, and maintained constant for ten hours, when another series of readings were taken, and so on until the temperature of the pipe had reached a point far above anything used in practice. The extremely high readings were taken as a matter of interest, as they were gotten when the low efficiency coverings were only at working temperatures.

Referring to the table (I), the first column refers to the number of curve, the second column gives the name of the covering which, in most cases, is sufficiently descriptive, but a brief description of each covering may be of interest.

TABLE I.—STEAM PIPE COVERINGS.

	Covering.	Aver. Thick. Inch	B. T. U. Loss per sq. ft. at 160 lbs. pr.	% Heat Saved by Covering
2	Solid Cork: Sectional	1.68	1.672	87.1
3	85% Magnesia: Sectional	1.18	2.008	84.5
4	Solid Cork: Sectional	1.26	2.048	84.2
5	85% Magnesia: Sectional	1.19	2.130	83.6
6	Laminated Asbesto Cork: Sectional	1.43	2.123	83.7
7	85% Magnesia: Sectional	1.12	2.190	83.2
8	Asbestos Air Cell [Indent]: Sectional ["Imperial"]	1.26	2.333	82.1
9	Asbesto Sponge Felted: Sectional	1.24	2.556	80.3
10	Asbestos Air Cell [Long]: Sectional	1.70	2.750	78.8
11	"Asbestocel" [Radial]: Sectional	1.22	2.801	78.5
12	Asbestos Air Cell [Long]: Sectional	1.29	2.812	78.4
13	"Standard" Magnesia: Sectional	1.12	....	...
14	"Magnesian:" Sectional	1.23	....	...
15	"Remanit" [Silk] Wrapped	1.51	1.452	88.8
16	85% Magnesia: 2" Sectional and ½" Block	2.71	1.381	89.4
17	85% Magnesia: 2" Sectional and ½" Plaster	2.45	1.387	89.3
18	85% Magnesia: 2-1" Sectional and ½" Plaster	2.50	1.412	89.1
19	85% Magnesia: 2-1" Sectional	2.24	1.465	88.7
20	85% Magnesia: 2" Sectional	2.24	1.555	88.0
21	85% Magnesia: 2" Sectional	2.21	1.568	87.9
	Bare Pipe [From Outside Tests]	...	13,000	...

No. 2. Solid sectional covering 1½ inches thick, composed of granulated cork moulded under pressure, and then baked at a tem-

perature of 500 degrees Fahr., ⅛-inch asbestos paper next the pipe, finished with resin paper and 8-oz. canvas.

No. 3. Solid 1-in. moulded sectional covering composed of 85 per cent. carbonate of magnesia, finished with resin paper and 8-oz. canvas.

No. 4. Solid 1-in. sectional covering, composed of granulated cork moulded under pressure and baked at a temperature of 500 degrees Fahr., ⅛-in. asbestos paper next the pipe; finished with resin paper and 8-oz canvas.

No. 5. Solid 1-in. moulded sectional covering composed of 85 per cent. carbonate of magnesia; outside of sections covered with canvas pasted on; finished with resin paper and 8-oz. canvas.

No. 6. Laminated 1-in. sectional covering, composed of nine layers of asbestos paper with granulated cork in between; outside of sections covered with canvas pasted on, ⅛-in. asbestos paper next the pipe; finished with resin paper and 8-oz canvas.

No. 7. Solid 1-in. moulded sectional covering composed of 85 per cent. carbonate of magnesia; ouside of sections covered with light canvas pasted on; finished with resin paper and 8-oz. canvas.

No. 8. Laminated 1-in. sectional covering composed of seven layers of asbestos paper indented with ¼-in. square indentations, which serve to keep the asbestos layers from coming in close contact with one another; ⅛-in. asbestos paper placed next the pipe; finished with resin paper and canvas.

No. 9. Laminated 1-in. sectional covering composed of 64 layers of asbestos paper, in which were embedded small pieces of sponge; outside covered with canvas pasted on; finished with resin paper and canvas.

No. 10. Laminated 1½-in. sectional covering composed of twelve plain layers of asbestos paper with corrugated layers in between, thus forming longitudinal air cells; ⅛-in. asbestos paper next the pipe; sections wired on and finished with resin paper and 8-oz. canvas.

No. 11. Laminated 1-in. sectional covering, composed of eight layers of asbestos paper with corrugated layers in between, the corrugations forming small air ducts radially around the covering; finished with resin paper and 8-oz. canvas.

TABLE II.—TOTAL EXPENSE—COST OF COVERING AND HEAT LOSS.

		$10,000		$20,000		$30,000		$40,000		$50,000		$60,000	
Thickness	First Cost	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss	% 1st Cost	% Loss
1.25"	$5550	55.5	44.5	27.8	72.2	18.5	81.5	13.9	86.1	11.1	88.9	9.3	90.7
2.00"	7880	78.8	21.2	39.4	60.6	26.3	73.7	19.7	80.3	15.8	84.2	13.1	86.9
2.50"	8660	86.6	13.4	43.3	56.7	28.9	71.1	21.7	78.3	17.3	82.7	14.4	85.6
3.00"	9550	95.5	4.5	47.8	52.2	31.8	68.2	23.9	76.1	19.1	80.9	15.9	84.1

No. 12. Laminated 1¼-in. sectional covering, composed of six layers of asbestos paper with corrugated layers, forming longitudinal air cells; outside of sections covered with two layers of canvas pasted on and finished with resin paper and canvas.

No. 13. Solid 1-in. moulded sectional covering composed of a magnesia compound mostly talc; ⅛-in. asbestos paper next pipe; finished with resin paper, and 8-oz. canvas. This sample was submitted for low temperature work only, such as boiler feed and drips.

No. 14. Solid 1-in. moulded sectional covering composed of magnesian compound principally talc; ⅛-in. layer of asbestos paper next the pipe; finished with resin paper and 8-oz. canvas.

No. 15. "Remanit," composed of two layers wound in reverse direction with ropes of carbonized silk. Inner layer 2½ inches wide, and ½ inch thick; outer layer 2 inches wide and ¾ inch thick, over which was wound a net work of fine wire; ⅛-in. asbestos next the pipe, finished with resin paper and 8-oz. canvas. Made in Germany.

No. 16. A 2½-in. covering, composed of 85 per cent. carbonate of magnesia, ½-in. blocks about 3 inches wide and 18 inches long next the pipe and wired on; over these blocks were placed solid 2-in. moulded sectional covering; outside covered with canvas pasted on. Finished with 8-oz. canvas.

No. 17. A 2½-in. covering composed of 85 per cent. magnesia in a 2-in. moulded section, wired on next the pipe, and over this a ½-in. layer of magnesia plaster covered with canvas pasted on, and finished with 8-oz. canvas.

No. 18. A 2½-in. covering composed of 85 per cent. carbonate of magnesia put on in two solid 1-in. moulded sections with ½-in. layer of magnesia plaster between; two ½-in. coverings wired on and placed so as to break joints. Finished with 8-oz. canvas.

No. 19. A 2-in. covering composed of 85 per cent. carbonate of magnesia put on in two 1-in. layers so placed as to break joints and finished with 8-oz. canvas.

No. 20. Solid 2-in. moulded sectional covering composed of 85 per cent. magnesia; outside of sections covered with canvas pasted on. Finished with 8-oz. canvas.

No. 21. Solid 2-in. moulded sectional covering composed of 85 per cent. magnesia; outside of sections covered with canvas pasted on. Finished with 8-oz. canvas.

Nos. 2, 4, 6 and 15 were excluded by the specifications, which stated that no inflammable material would be considered, but a test was made at the request of the manufacturers in order to give a comparison with the other materials.

It will be noted that two samples covered with the same thickness of similar material give different results; for example, Nos. 3 and 5, and also Nos. 20 and 21, though of practically equal thickness, show quite a perceptible difference in loss per square foot. Upon investigation, the cause of this difference was found to be in the care with which the joints between sections were made. A comparison between Nos. 19 and 20, showing two coverings having exactly the same total thickness, but one applied in a solid 2-in. section, and the other in two 1-in. sections, proved the desirability of breaking joints.

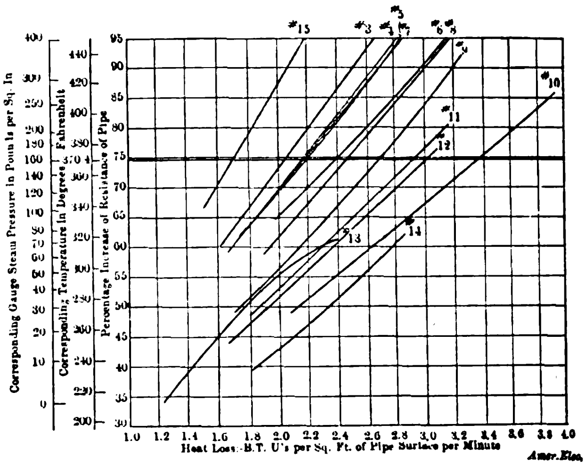

FIG. 3.—CURVES FROM COVERINGS OF THE SAME THICKNESS.

An attempt was made to determine the law governing the effect of increasing the thickness of the insulating material, and for all the 85 per cent. magnesia coverings the efficiency varied directly as the square root of the thickness, but the other materials tested did not follow this simple law closely, each one involving a different constant. The column on the right of Table I shows the percentage of heat saved by the different coverings, compared to bare pipe, at a pressure of 160 pounds.

In Tabe II and Fig. 3 an attempt has been made to reduce all coverings to the same thickness, and thus show the relative efficiency of different types of material at a wide range of pressure. One-inch covering was adopted as the standard, and only those coverings nearly 1⅛ inches thick were used in the comparison in order to avoid errors in calculating the losses in materials which did not follow the square root law closely. An inspection of the table and curves shows that the carbonized silk covering is the most efficient, having a relative efficiency of 86.9, whilst 85 per cent. magnesia comes second with 84.2 per cent. efficiency. The two other samples of 85 per cent. magnesia show efficiencies of 83.1 per cent. and 83.2 per cent., thus confirming in a remarkable way the results on the other sample.

RELATION TO STATION ECONOMY.

To determine which covering is the most economical the following quantities must be considered: (1) investment in covering; (2) cost of coal required to supply lost heat; (3) 5 per cent. interest on capital invested in the boiler and stoker capacity that has to supply lost heat; (4) guaranteed life of covering; (5) thickness of covering. It is apparent that the covering which shows a minimum total cost for the first three items at the end of a specified time is the best covering to adopt, for the loss in heat at the end of ten years may readily cost over three times as much as the first cost of the covering. To enable this to be seen more clearly, Table 3 was calculated, and the curves in Fig. 4 plotted.

A specific number of square feet of pipe surface has been used in working out the total cost, but it is evident that the curves may be used to determine the most economical thickness of covering, irrespective of the total amount of surface to be covered, as long as the cost per square foot of material for different thicknesses varies in the same manner as for 85 per cent. magnesia, which has been used in calculating the accompanying tables.

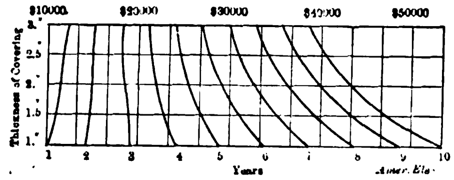

FIG. 4.—CURVES SHOWING RELATION BETWEEN THICKNESS OF COVERING AND TOTAL EXPENSE.

As the geometrical dimensions of the covering are a function of the cost of the increased thickness desired, it will generally be found that increasing the thickness of the material will increase the investment, as is shown in the curves for 85 per cent. carbonate of magnesia.

An inspection of the curves shows that before deciding which is the most economical thickness of covering to be used, it is first of all necessary to know how long the covering is expected to last. For example, suppose that a temporary plant is being erected which is not likely to be required for more than two years; in such a case, a 1-in. covering will be the most economical. Under a life guarantee of ten years, as required by the Manhattan Railway Company, 1-in. covering would show a total cost of $53,663, whilst a 3-in. covering would show a total cost of $38,668, making a net saving of $14,995 at the end of ten years, or $1,499.50 per annum, which, capitalized at 5 per cent. represents $29,990.

TABLE III.

	Covering	B. T. U. Loss per sq. ft. at 160 lbs.pr.	% Heat Saved by Covering
3	85% Magnesia: Sectional	2.060	84.2
4	Solid Cork: Sectional	2.170	83.3
5	85% Magnesia: Sectional	2.192	83.1
6	Laminated Asbesto Cork: Sectional	2.395	81.6
7	85% Magnesia: Sectional	2.184	83.2
8	Asbestos Air Cell [Indented]: Sectional ["Imperial"]	2.465	81.0
9	Asbestos Sponge Felted: Sectional	2.683	79.4
10	Asbestos Air Cell [Long]: Sectional	3.380	74.0
11	"Asbestocel" [Radial]: Sectional	2.920	77.5
12	Asbestos Air Cell [Long]: Sectional	3.015	76.8
13	"Standard" Magnesia: Sectional	....	...
14	"Magnesian:" Sectional	....	...
15	"Remanit" [Carbonized Silk] Wrapped	1.708	86.9
	Bare Pipe [From Outside Tests]	13.000	...

From the above example it will be seen that although the selection of pipe covering is a relatively small one of the many problems confronting the engineer, its scientific solution will yield results rich out of all proportion to the time required to solve it.

I would only add that there seems to be no reason for the former practice of putting on different thickness of covering on different sized pipes, excepting the mechanical difficulty of applying a very heavy covering to a small pipe. This difficulty can be overcome by putting the covering on in two separate layers, and this plan should be used on all sizes in order that the joints may be broken, as poor joints may reduce the efficiency of the best covering 6 per cent. or more.

[The foregoing is a paper read at the 23d convention of the Association of Edison Illuminating Companies.]

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MULTIPLE UNIT, VOLTAGE SPEED CONTROL FOR TRUNK LINE SERVICE.

BY H. WARD LEONARD.

In February, 1894, I read a paper before the American Institute of Electrical Engineers, describing a system which I considered applicable to the operation of a trunk line electric railway. The essential features of this system were:

1st. The generation and transmission of a high-tension, single-phase alternating current, the power houses being placed as far apart as the insulation of an alternating current transmission line would permit.

2d. The entire elimination of substations.

3d. A transformation of the energy upon the locomotive so as to secure a voltage speed control for the electric motors, thereby obtaining smooth acceleration and efficient control of the locomotive at any desired speed and in either direction.

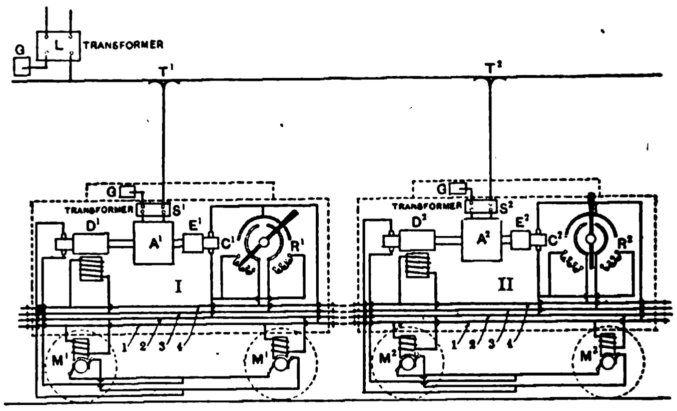

FIG. 1.—MULTIPLE UNIT VOLTAGE SPEED CONTROL.

At that time there were no engineers, so far as I know, who agreed with me that these features were essential for the operation of a trunk line railway by electric motors. In the recent past, however, many promient engineers both abroad and in this country have declared themselves in favor of these essential features, and I therefore feel warranted in describing an improvement upon the system originally proposed, by which I can secure the important and now well understood advantages of a multiple control of any desired number of locomotive units.

Fig. 1 illustrates diagramatically one form of my multiple unit voltage speed control as applied to two locomotive units for trunk line service. Single-phase alternating current is generated at as high an e. m. f. as is practicable to-day, say 20,000 volts. A moving contact leads the current to the locomotive. If desired, transformers can be placed at suitable points along the line of the railway which will reduce the initial e. m. f. to any desired e. m. f. for delivery to the contact conductor. In many instances it may be desirable to place upon the locomotive a transformer S^1 for reducing the e. m. f. of the alternating current led to the motor A^1.

A single-phase synchronous motor on the locomotive is driven continuously by the secondary current at a practically constant speed; the current after passing through the motor, being led to ground through a moving contact. This single-phase motor A^1 drives continually a small exciter, E^1, and also a large direct current dynamo D^1, whose field is separately excited by the exciter E^1 and has in its field circuit a reversing field rheostat R^1. The armatures of the propelling motors are connected in multiple directly across the terminals of the armature of the dynamo D^1. The field magnets of the propelling motors M_1 are separately and constantly excited by the exciter E^1.

By manipulating the reversing field rheostat R^1, the current through the armatures of the motors M^1 necessary to obtain the required tractive effort, can be obtained at any desired voltage from the lowest voltage to the full speed voltage, and in either direction. A perfectly smooth and rapid acceleration can thus be obtained with minimum energy from the source of supply.

The simultaneous multiple control of the several locomotive units is obtained by means of the four small wires *1*, *2*, *3*, *4*, which extend throughout. In the diagram, the operator is supposed to be upon the locomotive I. The exciter E^1, which is producing a constant e. m. f., has its terminals connected to the wires *1* and *2*. Across these wires are connected the field windings of all of the propelling motors on the two locomotives, so that they are all constantly and fully excited. The wires *3* and *4* are also supplied with current from the exciter E^1, but the reversing field rheostat R^1 is in the path of this current. The fields of the two dynamos D^1 and D^2 are connected in multiple across these wires *3* and *4*.

It will be evident that by manipulating

the reversing field rheostat R^1 the operator can vary simultaneously and similarly the field exciting currents supplied to D^1 and D^2, and that therefore he can cause the voltage of these two dynamos to vary in exact unison from zero to the maximum voltage in either direction. Thus, the operator can cause the two locomotives to start, accelerate, run at full speed, retard, and reverse in perfect unison, always dividing the load perfectly under these various conditions. By placing the controller R^1 in its open position and going to the other locomotives, the operator can similarly control the two locomotives simultaneously by means of the controller R^2.

Among the advantages inherent in such a system are these:

The haulage over existing roadbeds, grades, bridges, etc., of very much heavier trains than can be hauled by any steam locomotive; a material reduction in the cost of maintenance of ten electric locomotives as compared with steam locomotives; a very large increase in the number of trains of given weight and speed which could be operated from a given power house compared with either the series-parallel or the cascade systems; the first cost of equipment will be very much less than that of any system, for equivalent service, which involves the use of sub-stations; the cost of haulage per ton mine would be greatly reduced as compared with steam locomotives, especially because of the large increase in the weight of the train which can be hauled; difficulties due to electrolysis would be reduced to a minimum.

[The foregoing is an abstract of a paper read before the American Institute of Electrical Engineers, November 21, 1902.]

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Disastrous Station Fire in Guadalajara.—The sub-station of the Electric Light Company of Guadalajara, Mexico, was entirely destroyed on November 8 by fire which originated in a short-circuit between the high-tension lines at the entrance to the building. The building and its equipment were completely destroyed. Work has already been started on a new station, and it is to be hoped that the electrical construction work in the new one will be conspicuously superior to that which was evidently employed in the one just destroyed.

SIX-PHASE TRANSFORMATION.

BY A. S. M'ALLISTER.

For the transmission of electrical energy over long distances three-phase circuits are the most economical, as is well-known; but it can be shown that a rotary converter operated six-phase will give from 35 per cent. to 45 per cent. greater output than when operated three-phase. From these two facts, it is evident that economy dictates the transmission of energy by means of three-phase circuits, and its transformation to six phases before being applied to a converter.

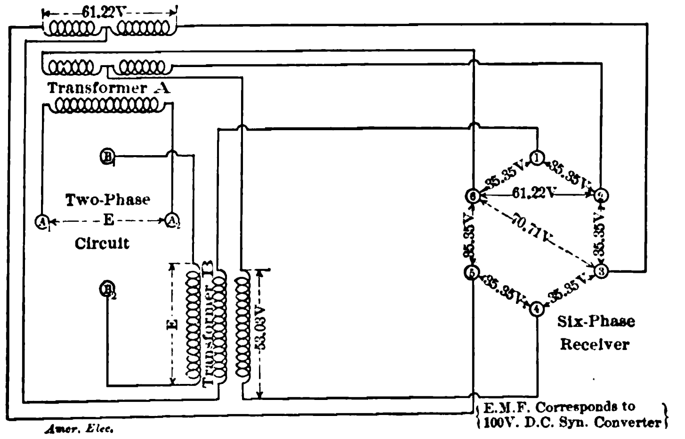


FIG. I.—TWO-PHASE TO SIX-PHASE TRANSFORMATION; TWO TRANSFORMERS, TEE SECONDARY.

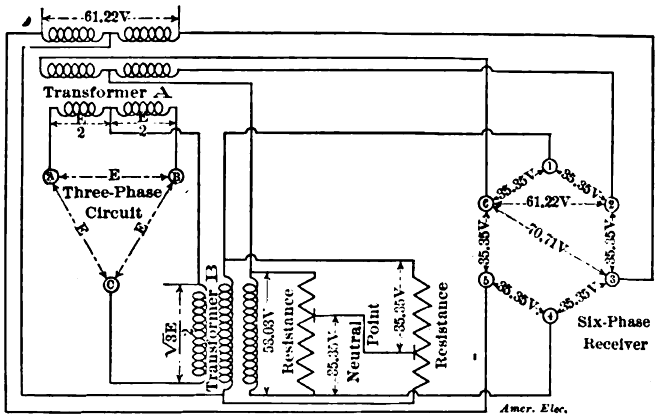
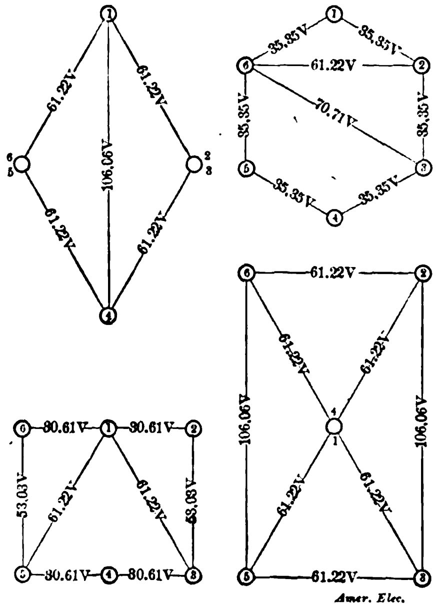


FIG. 2.—THREE-PHASE TO SIX-PHASE TRANSFORMATION; TEE PRIMARY, TEE SECONDARY.

The flexibility of polyphase circuits in general is well exemplified by the numerous interconnections of transformer coils which may be employed to produce six phases from two or three phases. The transformation from three to six phases may be accomplished by the use of three transformers, each having one secondary connected "star" fashion, or by three transformers, each having two secondaries, connected in "star," "delta" or "ring"; or by the use of two transformers, each with two secondaries, connected in "delta" or "tee"; or two transformers each with one secondary may be used as combined autotransformers and transformers to obtain the desired conversion. A few of the methods of transformation just mentioned are of interest only form an academic point of view, and such will not be further discussed; only those which possess points of special interest or are of practical value will be considered in detail.



FIGS. 3, 4, 5 AND 6.

In many respects a six-phase system may be represented as two superposed three-phase systems, and a certain degree of simplicity in tracing the transformation circuits may be obtained by keeping this fact in mind. This fact is somewhat emphasized by the method of transforming from two to six phases that is shown by Fig. 1. As will be observed, the two transformers are wound quite similarly to those used in the Scott method of transforming from two to three phases; the difference being in the division of each secondary winding into two parts. The six secondary coils are connected so as to form two three-phase systems. These two systems are twice reversed with reference to each other; electrically at the transformers, and mechanically at the six-phase receiver, so that the separate tendencies to motion would be in the same direction of rotation. Since there exists no interconnection between the two three-phase circuits the cross e. m. fs. shown in Fig. 1 can be observed only when the six-phase receiver of itself tends to produce such e. m. fs.

As a comparison between Fig. 1 and Fig. 2 will show, a relatively slight change in the primary coil of one transformer renders the two-phase to six-phase connections of circuits applicable to transformation from three to six phases. The resistances shown in Fig. 2 are not essential to the operation of a six-phase rotary converter or similar apparatus, though when such apparatus is absent the existence of e. m. fs. in six-phase relation can best be proved by the use of a voltmeter when resistance is thus used. By varying the points on the separate resistances which are joined together a variety of superposed three-phase e. m. fs. may be obtained, the existence of which may be proved by a voltmeter. Figs. 3 to 6 indicate a few of the symmetrical figures thus produced. Under operating conditions the generator action of a six-phase rotary converter causes the

e. m. fs. to assume the relation shown by Fig. 4, and the use of resistance for such purpose is entirely superfluous.

Perhaps of the many methods for transforming from three to six phases, the one possessing the greatest simplicity in transformer circuits is that in which the secondaries are star connected, and the primaries either star or delta connected. Fig. 7 shows such interconnection of circuits with the primaries connected in delta.

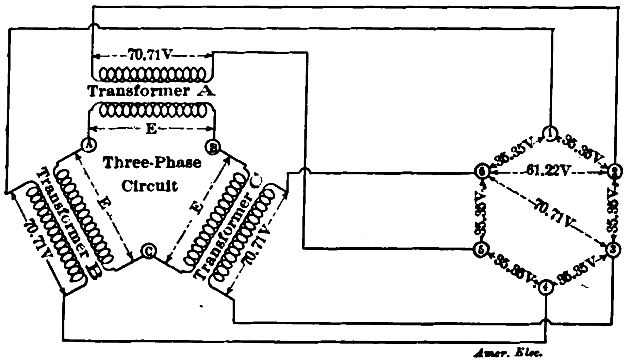

70.71V
Transformer A
E
A
B
Three-Phase Circuit
Transformer B
Transformer C
70.71V
E
C
35.35V
61.22V
70.71V
Amer. Elec.

FIG. 7.—THREE-PHASE TO SIX-PHASE TRANSFORMATION; DELTA PRIMARY, STAR SECONDARY.

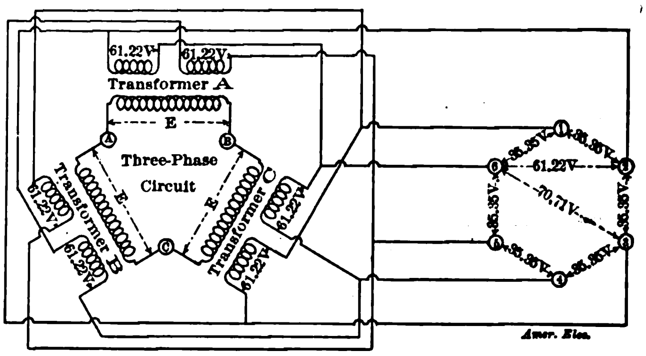

61.22V
61.22V
Transformer A
E
A
B
Three-Phase Circuit
Transformer B
Transformer C
61.22V
C
35.35V
61.22V
70.71V
Amer. Elec.

FIG. 8.—THREE-PHASE TRANSFORMATION; DELTA PRIMARY AND SECONDARY.

With the six-phase receiver absent, a voltmeter would register only three separate single-phase e. m. fs., and would indicate no cross e. m. fs between the phases. By tapping each secondary coil at its middle point, and joining these three points to form a common neutral, all the e. m. fs of the symmetrical six-phase receiver will be properly indicated on a voltmeter. As stated previously, however, the operation of a six-phase receiver does not depend upon the production of the symmetrical figure external to the receiver and the performance will be quite satisfactory without joining the three neutral points of the separate single-phase circuits.

Fig. 8 indicates connecting circuits for three-phase to six-phase transformation, both primary and secondary coils being connected in delta. No change whatever need be made in the connections of the secondary circuits in order to operate the primary coils in star, though the e. m. f. per primary coil would thereby need to be decreased in the ratio of √3 to 1, of course.

A comparison of Fig. 8 and Fig. 9 will reveal the fact that the same transformers may be used for either delta or ring connected secondaries, though a change in the ratio of primary to secondary turns per coil would be necessary in order to operate the receiver at the same e. m. f. for the two methods of transformation; the change being as the ratio of the side of an equilateral triangle to that of a regular hexagon inscribed within the same circle.

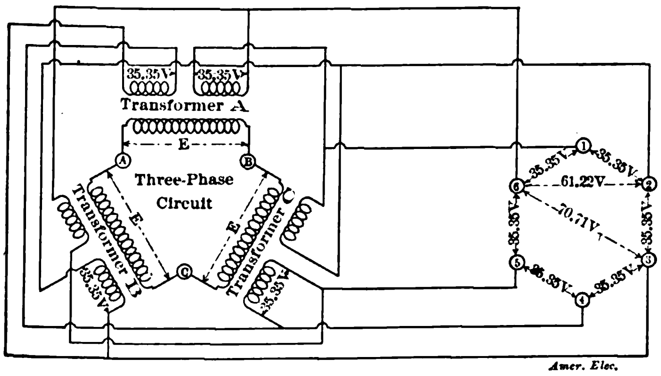

35.35V
35.35V
Transformer A
E
A
B
Three-Phase Circuit
Transformer B
Transformer C
35.35V
C
61.22V
70.71V
Amer. Elec.

FIG. 9.—THREE-PHASE TO SIX-PHASE TRANSFORMATION; DELTA PRIMARY, RING SECONDARY.

Since, when three transformers are connected in delta, one may be removed without interrupting the performance of the circuit —the other two transformers in a manner acting in series to carry the load of the missing transformers—the desire to obtain immunity from a shut-down due to the disabling of one transformer has led to the extensive use of the delta connection of transformers especially on the low potential six-phase-side.

A change from delta to star in the primary circuit alters the ratio of the transmission e. m. f. to the receiver e. m. f. from 1 to √3. On account of this fact, when the e. m. f. of the transmission circuit is sufficiently high that the successful insulation of transformer coils becomes of constructive and pecuniary importance, the three-phase line side of the transformers is frequently connected in star.

◆◆◆

ELECTRICALLY OPERATED COAL HOIST, HAVING VARIABLE SPEED CONTROL.

BY P. O. KEILHOLTZ.

The use of electric machinery for coal hoisting has many advantages over steam machinery when the hoist is considerable. It has also the advantages of less cost of operation and maintenance. Its initial cost, however, is greater.

There are two distinct operations in coal hoisting; raising the loaded shovel and lowering it empty. All that is required for raising is a smooth acceleration for closing and raising the shovel, and full power application as long as possible in order to decrease the time of hoisting. Full power application can be continued longer with an electric hoist than with steam, owing to the less inertia of the former. A smooth acceleration is required because the cables are without stretch and for very high hoists would introduce objectionable strains in the structure or damage to the gearing.

It is in lowering the empty shovel that the electric hoist has marked advantages. With a steam hoist the lowering is accomplished by braking, and with high hoists, large shovels and rapid lowering, the large amount of heat generated by the brakes is difficult to get rid of. As brakes depend upon friction, which is a function of two things—the surface conditions and the pressure between the rubbing surfaces—the amount of friction is uncertain, and braking, therefore, is objectionable because violent surgings are introduced in the boom structure and tower. With the electric hoist, owing to the perfect reversibility of the electric motor, the motor is used as a generator having a separately excited field and driven by the weight of the descending bucket. In its armature circuit is a rheostat to dissipate the heat generated. It is at once apparent that this heat dissipation can be better accomplished with a rheostat than with a brake band.

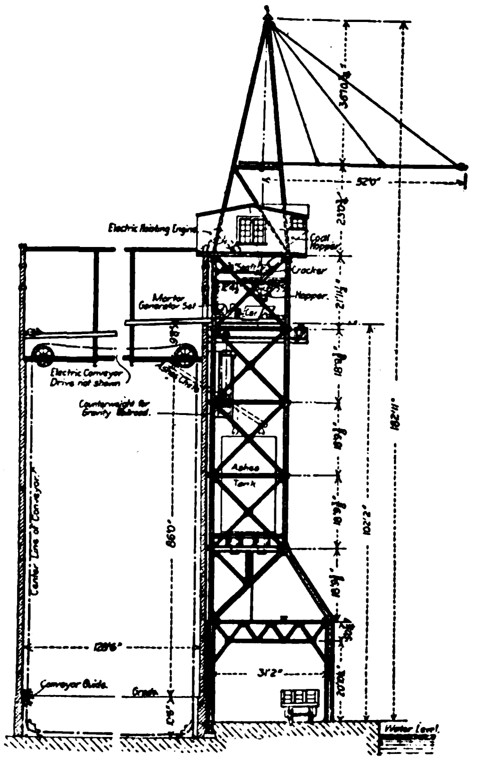

36'10½"
52'0"
Electric Hoisting Engine
Coal Hopper
23'0½"
Cracker
Hopper
21'1¼"
Motor Generator Set
Car
Electric Conveyor Drive not shown
Counterweight for Gravity Railroad
18'9½"
18'9½"
Ashes Tank
18'9½"
102'2"
182'11"
86'0"
Center Line of Conveyor
18'9½"
128'6"
31'2"
Conveyor Guide
Grade
Water level

FIG. I.—COAL-HOISTING TOWER.

The Ward Leonard system of control is used and the apparatus consists of a motor-generator set, comprising a 450-h. p. motor and a 450-kw. dynamo, and a hoist motor of 200 horse-power which receives its power from the motor-generator set, the motor of which is supplied with a 550-volt direct current. The dynamo is a 250-volt machine, as is the hoisting motor. The field of the generator is separately excited and its strength is controlled by the operator by means of a foot operated rheostat. The field of the hoist motor is excited by the 550-volt direct current. By means of a double throw, three-blade switch the foot rheostat is cut out of the generator field circuit and cut into the field circuit of the hoist motor; and the armature leads of the hoist motor cut from the armature circuit of the generator to the rheostat.

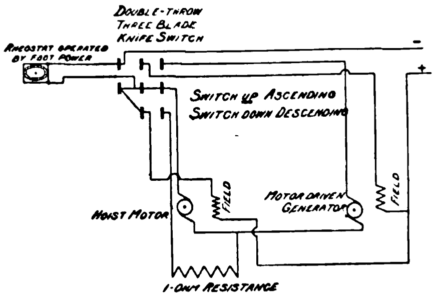


FIG. 2.—DIAGRAM OF CONNECTIONS.

Appended will be found sketches of coal hoisting tower, wiring diagram, distance-time curve and a velocity curve, together with data of test and other particulars.

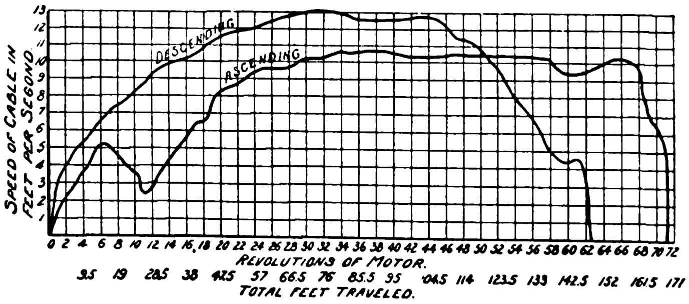


FIG. 4.—DESCENDING AND ASCENDING VELOCITY CURVES.

From the velocity curve (ascending) it will be seen that it took 11 seconds to close the shovel, and from the distance-time curve 26 seconds to close the shovel and raise it to the dumping hopper. Therefore 15 seconds is the time taken to raise the loaded shovel; and as the lift is 126 feet, the average velocity is 8.4 feet per second.

PARTICULARS OF TEST.

Weight of coal hoisted, average 7 shovelfuls	2,337 lbs.
Weight of shovel empty	2,900 lbs.
Total weight, lifted exclusive of weight of ropes	5,237 lbs.
Average lift	126 ft.
Readings of main motor.	
Volts	540
Average current in amperes to close shovel	57
Maximum current in amperes to close shovel	73
Average current in amperes to raise loaded shovel	189
Maximum current in amperes to raise loaded shovel	243

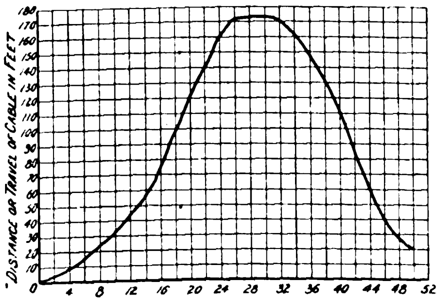


FIG. 3.—DISTANCE—TIME CURVE.

Field current, not included, in above, 2.8 amperes.

The efficiency is

$$\frac{\dfrac{8.4 \times 5237}{550}}{\dfrac{189 \times 540}{746}} = 58\tfrac{1}{2}\%$$

Performance test: Coal lifted, 101.86 tons; times, 87.33 minutes; rate, 70 tons per hour.

[The foregoing is a paper read before the American Institute of Electrical Engineers, November 21, 1902.]

Abstracts from Foreign Contemporaries

Trolley Wire Safety Device.—The accompanying illustrations taken from the London *Electrical Review,* show a simple and ingenious device for the prevention of accidents from fallen trolley or telephone wires. The device, which is known as an "automatic self-adjusting circuit-breaker," is fitted in the feeder pillars and consists of two pivoted levers held in an upright position when the current is on by two magnets with shunt coils. In the event of a trolley wire breaking, the lever on that section is instantly released and, falling over, makes contact by a bridged piece between the faulty section and earth, which blows the fuse and cuts the section out. The levers are so shaped that should a right-hand section break just after a left-hand one, or *vice versa,* the second one is free to operate after the first one. This will be understood by reference to Fig. 1, which shows the construction of the pivoted levers. The great advantage claimed for this device is that while operating instantly in the event of a breakage of one or both sections of trolley lines, it does not operate when the current is cut off at the source of supply, as at the end of a run or for other reasons; because when the current is cut off at the section pillar or station, both of the levers are released at the same instant, and after a slight movement engage with each other, remaining in such a position as to be readily attracted and restored to their normal position when the current is again switched on at the source of supply. Fig. 2 shows the mode of connecting, and also the apparatus with the left-hand section broken or cut out. It will be seen that the instrument requires no attention whatever when once installed. To enable the device to deal with fallen telephones or other wires, an additional coil of the same ampere turns as the shunt coil but wound differentially is placed on the same magnet, as shown in Fig. 3. The guard wires are earthed through this additional coil, and should telephone or other wires fall across the trolley line and guard wires and come in contact with them, the current flowing through the additional coil causes an equal but opposing effect in the shunt coil. The magnet becoming dead releases the lever, which operates in the usual way.

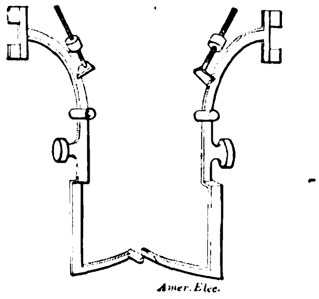


FIG. 1.—PIVOTED LEVERS.

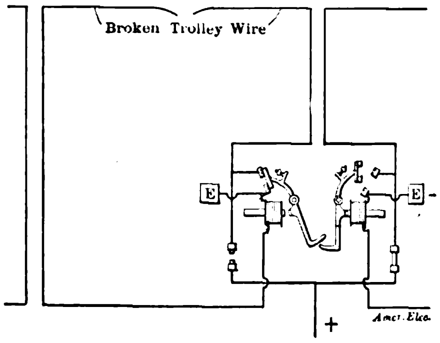


FIG. 2.—LEFT-HAND SECTION CUT OUT.

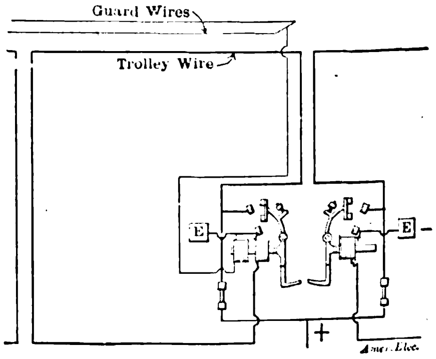


FIG. 3.—TROLLEY WIRE SAFETY DEVICE.

Efficiency of Non-Conducting Compositions.—*The Mechanical Engineer,* of London, contains an abstract of a paper by Prof. T. Hudson Beare, who for three years has carried out a considerable number of experiments to determine the efficiency of various non-conducting compositions when used on steam piping. The experiments were performed with a piece of ordinary wrought-iron steam pipe, 8ft. 10½ ins. long, having a mean internal diameter of 3.53 inches, the average thickness of the metal being ¼ inch. The following series of observations were made in each set of experiments: (1) The air temperature of the room, which was taken in two or three different places; (2) the pressure of the steam as it entered the pipe; (3) the amount of steam condensed in the pipe and two ends, due to radiation, every half-hour; (4) the temperature of the outside of the covering. There was no practical difficulty in taking the first three of these observations; all the temperatures were read at frequent intervals; and the pressure gauge used was carefully calibrated against a mercury column on several occasions while the experiments were going on. The fourth observation—the temperature of the steam covering was, however, a very difficult one to carry out, and not very much reliance can be placed on the results obtained. After trying several plans, the method eventually adopted was to employ a special thermometer, made with a very thin flat bulb; a shallow groove was then cut in the side of the covering near the center of the pipe, and the thermometer was suspended from the roof by a cord in such a position that the bulb just fitted into the groove in the covering; it was kept in this position by pasting a piece of thin paper on to the covering on each side of the bulb. If the results obtained were not the exact temperature of the outside of the covering, they at any rate gave comparable results when contrasting one covering with another. The method of carrying out an experiment was as follows: Steam was raised in the boiler early in the morning and turned into the apparatus, which was then allowed to stand under steam for several hours; all the steam condensed during this time was constantly drained off, but not collected or weighed. As soon as everything was at a uniform temperature (which was always shown by the thermometer on the outside of the covering remaining stationary), an experiment was started; each experiment then lasted for two hours, or longer if necessary. The weight of steam condensed during each half hour was accurately determined, and if any experiment showed a discrepancy of any character in these weighings the results were rejected or else the experiment was immediately repeated with a view to determine the disturbing cause.

Seven non-conducting compositions in all were experimented with, and for each steam pressure experiments were also made on the steam pipe bare. The gauge steam pressures adopted in the experiments were 45 lbs., 80 lbs., and 135 lbs., and a few observations were also made with gauge pressures of 3 lbs. and 59 lbs. in the case of the uncovered steam pipe. The accompanying table gives the results obtained in a handy form for reference under the following headings: Nature of the covering, air and steam temperatures, the weight of the covering both in the loose condition and when applied to the pipe and dry, thickness of the covering and its external temperature, loss of heat per square foot in thermal units and in pounds of steam condensed, calculated on the external surface of the bare pipe. One point of considerable importance to the user is given in the table, namely the weight of the covering per cubic foot when dry on the pipe. This is a very important matter, especially in the case of steam pipes, where a considerable increase in the weight of the pipe, when it has to be supported, is a distinct disadvantage. Though an attempt was made to keep the coverings all of exactly the same thickness, it was not found possible to do so, and, therefore, it varies slightly in different experiments, but not to any marked extent.

Kind of Covering.	Thickness of Covering, inches.	Weight of 1 cub. ft. of Covering loose. lbs.	Weight of 1 cub. ft. of Covering on Pipe dry, lbs.	Steam Pressure by Gauge, lbs. per square inch.	Temperature (Fahrenheit). Steam in Pipe.	Temperature (Fahrenheit). Air in room.	Temperature (Fahrenheit). Outside of Covering.	Loss of Heat. B.T.U. per square foot of external surface of uncovered pipe per hour.	Condensed Steam. Pounds per square foot of external uncovered surface of pipe per hour.
SERIES A.									
Uncovered pipe	..	..	..	3	223	64.5	...	360.3	0.376
Uncovered pipe	..	..	..	59	306	62.4	...	697.0	0.775
SERIES B.									
Uncovered pipe	..	..	..	46.5	294	94	...	564.0	0.622
Asbestos No. 1..............	1.42	39	49.8	45	292	61.9	125	213.3	0.235
Asbestos No. 2..............	1.39	..	..	45	292	59.3	115	182.9	0.202
Asbestos No. 3..............	1.42	28.6	38.9	45	292	56.8	108	172.1	0.189
Asbestos No. 4..............	1.54	22.7	33.6	46	293	65	...	134.0	0.148
Asbestos No. 4..............	1.43	22.7	33.6	47	294	68.5	116	147.3	0.162
Fossil-meal composition.........	1.40	73.8 wet	47.5	44	291	61.3	112	182.1	0.201
Patent non-conducting composition	1.38	22.5	38.3	47	294	63.7	120	168.9	0.186
SERIES C.									
Uncovered pipe	..	..	..	80	324	66	...	767.0	0.866
Uncovered pipe	..	..	..	86	328	68.3	...	775.0	0.878
Asbestos No. 1..............	1.42	39	49.8	70	323	59.9	132	262.4	0.295
Asbestos No. 1..............	1.50	*..	*..	80	324	61	135	202.6	0.229
Asbestos No. 2..............	1.39	..	..	76	321	60.7	123	221.4	0.250
Asbestos No. 3..............	1.30	*..	*..	83	327	67	116	163.5	0.185
Asbestos No. 3..............	1.42	28.6	38.9	79	323	59.4	119	192.0	0.217
Asbestos No. 4..............	1.54	22.7	33.6	79	323	66.2	...	168.3	0.190
Asbestos No. 4..............	1.43	22.7	33.6	80	324	62.6	118	180.9	0.204
Fossil-meal composition........	1.30	*..	*..	81	325	79	140.8	232.0	0.262
Fossil-meal composition........	1.40	73.8 wet	47.5	78	322	65.6	130	207.5	0.234
Patent non-conducting composition	1.38	22.5	38.3	80	324	64.1	130	192.0	0.217
Mica sectional covering........	1.14	*..	*..	80	324	80	114.5	134.7	0.152
SERIES D.									
Uncovered pipe	..	..	..	135	358	67	...	903.0	1.050
Asbestos No. 1..............	1.50	*..	*..	149	365	62	131.8	271.7	0.318
Asbestos No. 3..............	1.30	*..	*..	137	359	75	120	208.0	0.242
Fossil-meal composition........	1.30	*..	*..	134	358	78	163	252.5	0.293
Mica sectional covering	1.14	*..	*..	130	355	79	119.4	150.3	0.174

*NOTE.—In the case of these experiments the weight of the covering when dry upon the pipe per square foot of external surface of pipe uncovered was determined by careful measurement and weighing. The results are as follows:

Asbestos No. 1	10.2	lbs. per square foot of pipe surface.
Asbestos No. 2	7.4	lbs. per square foot of pipe surface.
Fossil-meal composition	8.24	lbs. per square foot of pipe surface.
Mica sectional covering	4.73	lbs. per square foot of pipe surface.

Double Safety Valve.—The double safety valve shown by Fig. 4 herewith, and described in a recent issue of the London *Engineering,* was devised with a view to reducing the enormous amount of dead weight required for safety valves of high pressures, particularly for water-tube boilers. The feature of novelty is the arrangement for counterbalancing the weights of the inner brass tube. It is carried in a fork at the end of a lever which at its other end carries a counterweight which can be adjusted along it to insure that the inner tube follows the upper valve. The lower end of the tube is open, and has a valve surface around it corresponding to a fixed seat in the main casting. The upper end of the tube, which is of larger bore than the lower end, is closed by dead weights in the usual way. The steam pressure tends both to raise the tube and the upper valve, but the upper valve, owing to its larger area, would naturally lift first. The tube, however, follows it simultaneously and is held against the upper valve by the counterweighted lever and, also, of course, by the steam pressure on an area corresponding to the upper

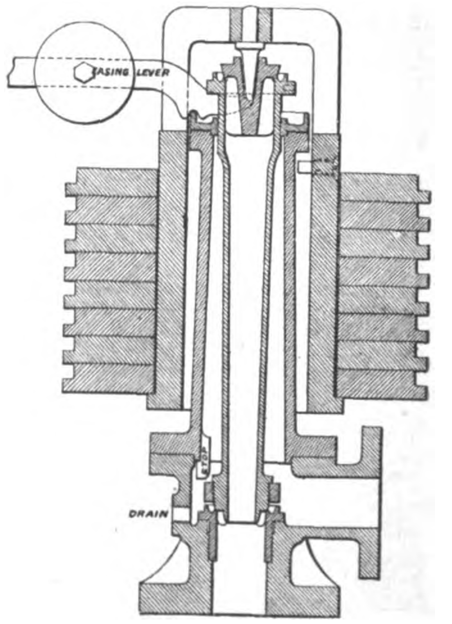
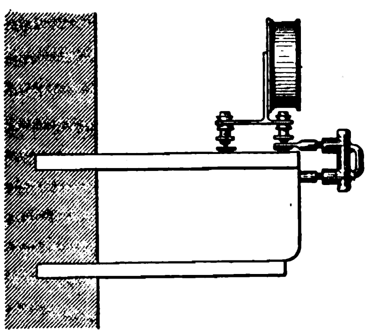


FIG. 4.—DOUBLE SAFETY VALVE.

valve seat. Steam then escapes at the lower valve seat. If, however, the steam pressure is sufficient to raise the lower valve until the ring around the tube meets the stop, the tube can no longer follow the upper valve, which then opens and affords a second outlet. The two valves are quite independent of each other, and if either should stick it will not affect its fellow. The makers have found it an advantage to contract the lower end of the tube, making the outlet sufficient to discharge all the steam possible to be generated with a consumption of coal of 25 pounds per square foot of grate area. The safety valve requires only a single pipe for the emission of the waste steam.

Ferranti Electrostatic Voltmeter Cutout.—One of the chief difficulties met with in the use of high-tension electrostatic voltmeters on supply station switchboards is the sparking across between the still and movable vanes. This is due to a variety of causes. In the first place, in order to get great sensibility, the moving and still parts are placed too near to give a large factor of safety. Transient rises in potential due to switching operations are also a cause of trouble in this direction. Then, again, a voltmeter which would have a comparatively large factor of safety in good dry air, under certain conditions will have its sparking voltage very much lowered due to dampness in the atmosphere or the presence of ozone as a result of silent discharges between the plates. Various protective devices have been proposed for use in this direction. It has been usual to place fuses and resistances in series with the voltmeter. The function of the resistance was to keep the current so small that the spark inside the voltmeter would not be sufficient to damage the instrument, while the fuse was to break the circuit when a spark occurred. Many difficulties were, however, encountered; for instance, it was very difficult to get a resistance of sufficiently high value to keep the current small enough not to do any harm. Then, again, any wire fuse cannot be made of sufficiently low fusing capacity to blow with this small current. If the current should continue to flow some time without blowing the fuse, the energy liberated in the resistance is so great as to make the latter very hot, and cases have occurred in which the resistance itself has been broken and an arc started across its terminals. It has been proposed to use spark-gaps in parallel with the voltmeter. It is an advantage in certain circumstances, however, to have a choking coil in series with the voltmeter, and this is essential with overhead transmission lines, which are subjected to atmospheric electrical disturbances; but with underground cables, choking coils need only be applied when flare switches are used on high-tension alternating-current circuits, and in similar cases.



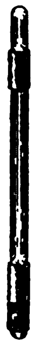


FIG. 5.—VOLTMETER CUT-OUT.—FIG. 6.

The new resistance cutout made by Messrs. Ferranti, and briefly described in the London *Electrician*, appears to answer requirements in connection with underground mains. It consists of a small glass tube (Fig. 6) filled with water of a certain conductivity. A small valve is made in the glass tube near the bottom, consisting of a hole covered with a piece of rubber tubing somewhat similar to the rubber valve of a bicycle tire. The current is led in at the top and bottom of the glass tube by means of platinum wires fused into the sides of the tube. These are connected on the outside to brass terminals, and the whole is enclosed in an outer porcelain case with plugs which fit into the terminals underneath the voltmeter. Fig. 5 shows the whole device mounted upon contacts. Should a spark occur for any reason—such as a short circuit inside the instrument—the water inside the glass tube will vaporize, and force itself out through the valve, thus safely breaking the circuit. The resistance of the water is extremely large; in fact it is so adjusted as to be only low enough to allow sufficient current to flow through to boil the water. Even if the water be of much less conductivity than this, no difference whatever is said to be observed on the reading of the instrument.

The "Supra" Brush Holder.—This new brush holder which is described in the London *Electrical Review* and shown by Fig. 7 herewith, is made up of two independent steel parts, one inserted in the other. One is tightly fixed by means of a split ring on the rod supporting the brush holder, while the other freely oscillates around the rod by means of rings. The fixed part carries at its opposite extremity a tension spring which is connected with the moving part; this spring presses the brushes radially upon the commutator. The second part, constituting the brush holder proper, is composed of two pieces, which together form a gripper between the jaws of which the carbon brush is tightly held by means of a second spring, as shown in the illustration. The powerful grip exercised by means of the great leverage obtained ensures intimate contact between the brush and the flexible copper conductor, which conveys the current to the brush-holder carrier. The use of steel enables the parts to be made light and strong, so that the brush easily follows irregularities of the commutator surface, and the spring pressure is exercised in the most effective manner.

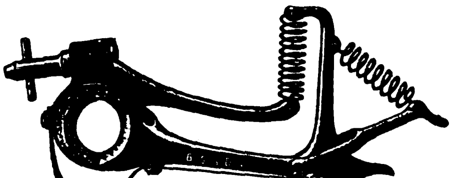


FIG. 7.—"SUPRA" BRUSH HOLDER.

Testing Insulation Resistance.—T. Bruger describes in a recent issue of the *Elektrotechnische Zeitschrift* a simple method of testing the insulation resistance of a direct current network during working. In the case of a two-wire network, a battery and adjustable resistance are connected between the negative main and earth, the e. m. f. of the battery being in opposition to the potential of the main. A galvanometer is also connected between the same main and earth, and the resistance is adjusted until the galvanometer shows no deflection. Then if E and e be the voltage of the network and battery respectively, and W be the value of the adjustable resistance when no current flows through the galvanometer, the fault resistance of the positive main is $\frac{E}{e} W$. Thus, if E is 200 volts and e, 20 volts the fault resistance is $10W$. The test is then repeated on the positive main and this determines the fault resistance of the negative main in the same way. In applying the method to a three-wire network, assuming that the middle wire is not earthed or that its earth connection has been removed, the battery, resistance and galvanometer are connected in the same way to each of the two outers in turn. In this case it is assumed that $E = e$; *i. e.*, that the auxiliary battery has the same voltage as the network. The fault resistances of the individual wires of the network are not obtainable separately, but the insulation resistance of the network as a whole is given by the formula $\frac{2W_1W_2}{W_1 + W_2}$, where W_1 and W_2 are the values of the resistance for balance on each of the two mains as explained above. On a five-wire network in which the test has been made on the outers in the same way, the insulation resistance would be $\frac{4W_1W_2}{W_1 + W_2}$.

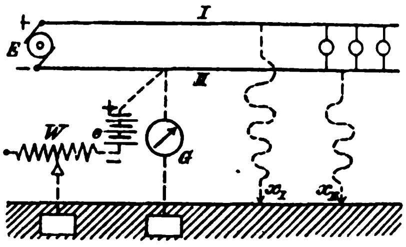


FIG. 8.—TESTING INSULATION RESISTANCE.

Zinc Plates for Boiler Protection.—A modification in the construction of zinc plates for the protection of boilers against corrosion is described in a recent issue of the London *Engineering*. The arrangement is shown in the accompanying engraving. The object of the invention is to keep the zinc in metallic contact with the structure of the boiler, so long as any of the zinc plate remains. With ordinary solid zinc plates, the part immediately in contact with the stud by which the plate is held, soon becomes corroded, and although there may be a substantial part of the plate left, it is doing little or no good, and may thus be the cause of a deceptive feeling of security when the boiler is examined. In order to overcome this defect, a mesh of iron wire is embedded in the zinc plate, the wire having a central boss for attachment to the ordinary stud as shown. A lead washer is provided to insure perfect metallic contact between the core and the stud. The zinc wastes but the iron does not, and metallic contact with the boiler is thus maintained so long as any zinc remains. It is claimed that the arrangement is especially suitable for use in water-tube boilers, as with the ordinary plate particles of zinc are liable to become detached and fall into the tubes, thus checking circulation. When the metal is held together by the iron mesh, naturally this does not occur. The inventor of the device is of the opinion that very often sufficient attention is not paid to the quality of the zinc used for boiler protection. If impurities are present, local currents are set up between the points in the surface of the plates, and their efficiency is greatly reduced. As will be seen, the invention is of an extremely simple character, but its advantages are apparent.

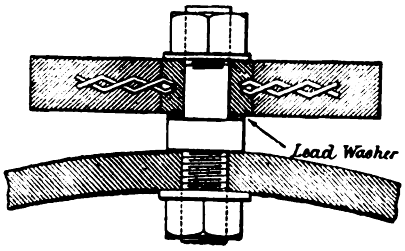


FIG. 9.—ZINC PLATE FOR BOILER PROTECTION.

Condenser and Dynamometer Brake.—London *Engineering* contains an article on the Manchester Municipal School of Technology in which are described a condenser and dynamometer brake which should be of interest to every engineer. The condenser is shown by Fig. 10 herewith. The steam enters at *a* and passes outside the tube *b* and inside the tube *c* finally escaping at *o*. The circulating water enters at *d*, passes through the narrow annular space between the two tubes and escapes at *e*. The inner surface of the tube *c* and the outer surface of the tube *b* are roughened so as to retard the flow of the steam; while the contraction of the annular space between the tubes causes the circulating water to flow with great rapidity. It is believed that the additional pumping power that may be needed for any increased surface friction, will be compensated for by the higher efficiency and reduction in space occupied. It is stated that a condenser of the type illustrated has effected the condensation of steam at atmospheric pressure at the rate of no less than 113 pounds per square foot of cooling surface per hour. This is far beyond that ordinarily obtained in practice. The dynamometer brake is shown by Fig. 11. It is a band brake, consisting of two pieces of steel riveted together, one on top of the other, leaving a shallow space between for water circulation. The circulation of water in the space is very rapid, on the principle applied in the condenser. Beech slabs are bolted to the cast-iron wheel to prevent too rapid wear or the possibility of firing. The band goes once round the wheel, the tight end being fastened to the lever, and tending to raise the latter. The slack end passes over a pulley on the ceiling and back to the lever, thus tending to pull it down. The difference is recorded by means of a diaphragm and gauge. The band can be tightened by means of a screw and wheel at *R*. The point of application of the slack side of band to the lever can be altered by means of the screw at *S*. For regulating the weight on the brake there is a novel arrangement at the opposite end of the lever shown by Fig. 11. This, it will be noticed, consists of a double-walled tank, the inner wall forming an inner circular vessel. The weights which depress the brake lever have beneath them what is known as a buoyancy tank *T*, which is partly submerged in the inner vessel. A tap continually supplies water to the tank at a constant rate, and this water escapes at a rate which may be varied by a governing device. The bottom of the inner circular vessel is surrounded by a fixed ring on the bottom of the tank. This ring is pierced by holes, and in the bottom of the circular vessel there are corresponding holes of the same size. The circular tank is capable of turning on its vertical axis, and in this way a multi-ported valve is formed. To regulate the escape of water automatically there is a centrifugal governor, shown at *U*, mounted on the top of the tank and driven from the engine shaft. This by suitable mechanism operates a valve in the bottom of the tank, opening or closing it as the speed of the engine varies. By this device the acting weight on the lever is varied according to the conditions of running of the engine, as the height of water level in the inner vessel is governed by the rate of flow. The device is intended to check hunting due to cyclical variations of torque. It is pointed out that with a hand brake on an engine fly-wheel two things may happen. First, the coefficient of friction between the band and wheel may vary from some cause other than change of angular velocity of the fly-wheel;

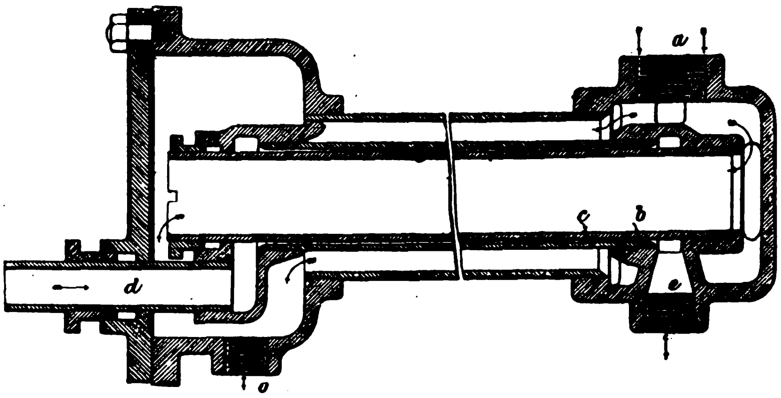


FIG. 10.—SECTIONAL VIEW OF CONDENSER.

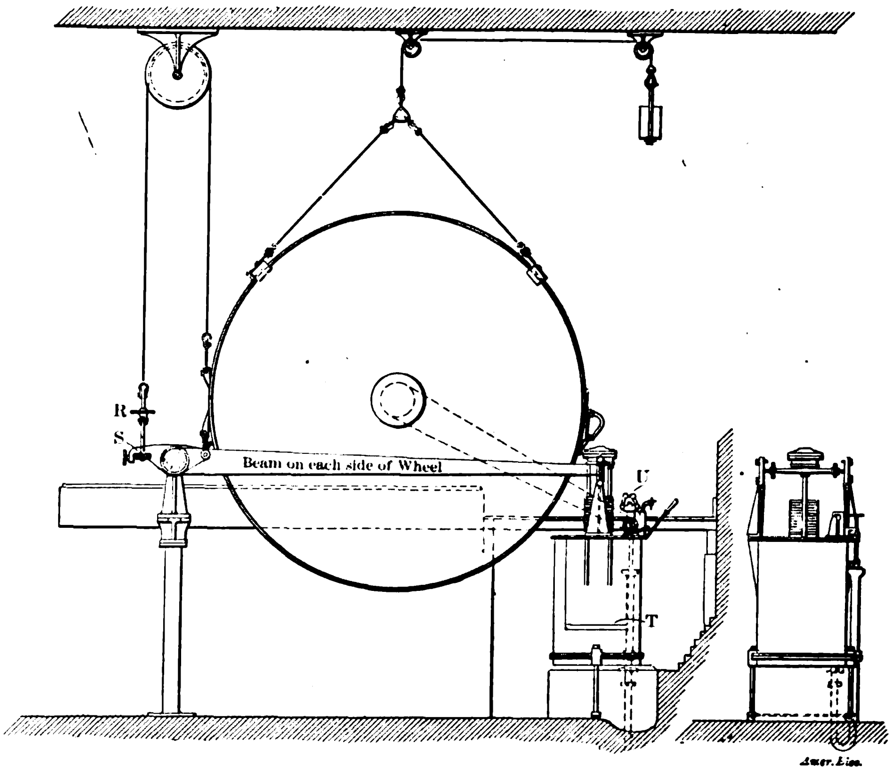


FIG. 11.—DYNAMOMETER BRAKE.

or, second, a change of speed may occur due to change of steam pressure, and consequently equilibrium between brake and engine torque would be destroyed. In the first case, supposing a friction increase, the weights and buoyancy tank will be raised, thus putting more load on the brake lever, and so tending to restore equilibrium. At the same time the speed of the engine would have diminished and the governor balls would tumble in, closing the water valve and tending to float the tank up. This would reduce the brake load, and speed up the engine again. In the second case, it is supposed the engine speed increases due to greater engine torque. This requires additional weights on the brake arm, an end which is attained by the governor balls flying out and opening the waste valve. The buoyancy of the tank is reduced, thus making the weights more effective. The coefficient of friction between the band and wheel also diminishes with increase of speed, and so needs some correction.

Some Recent Electrical Patents

Magazine Fuse-Block.—The advantages of a magazine fuse-block are so well known as to require no dissertation on that subject. One of the latest forms of this type of appliance is shown by Figs. 1 and 2 herewith, and has been patented by Charles E. Egan. The fuses are screwed to a common terminal, *K*, at one end, and the other ends are screwed to the free ends of individual strap springs, *M*, M_1, M_2 and M_3. Behind the fuse ends of these springs are contact points *N*, N_1, N_2, etc. The springs are held out of contact with these by the fuses and connections are made on the back of the base from the lower end of one spring to the contact point of the neighboring spring, as indicated in Fig. 2. When the first fuse melts, the spring *M* is released and rests upon its contact *N*, transferring the circuit to the second spring and fuse, and so on. Patent No. 708,329.

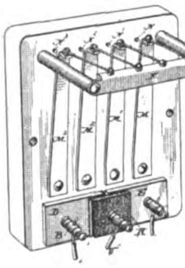


FIG. 1.

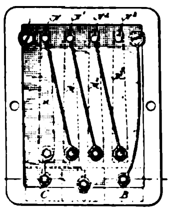


FIG. 2.

Three-Phase Switchboard Ammeter Connection.—It has thus far been the practice in connecting phase ammeters on three-phase switchboards to carry an individual pair of leads from each ammeter to the instrument transformer of its phase, as indicated in Fig. 3. Remembering that the current in any one wire of a three-wire, three-phase system is always the resultant of the currents in the other two wires, it will be perfectly evident that ammeters connected as shown in Fig. 4 will indicate the respective current values exactly as though connected individually, as in Fig. 3. This fact has obviously occurred to J. E. Woodbridge, of the General Electric Co., who has patented the arrangement illustrated. Fig. 5 shows a modification in which one transformer is omitted, this being equally permissible with current transformers and potential transformers. The ammeter circuit is shown grounded in all three diagrams; the effect of this is to produce a Y-connected system in the arrangement shown by Fig. 3, but it is not clear that it produces any effect upon the current flow in the other arrangements. The new connections evidently possess the very material advantage of eliminating self-induction in the ammeter leads, assuming that the leads *18*, *19* and *20* would be in intimate juxtaposition wherever they run parallel. Patent No. 713,583.

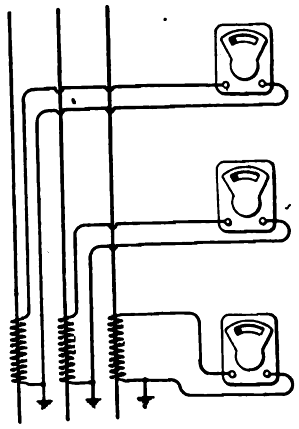


FIG. 3.

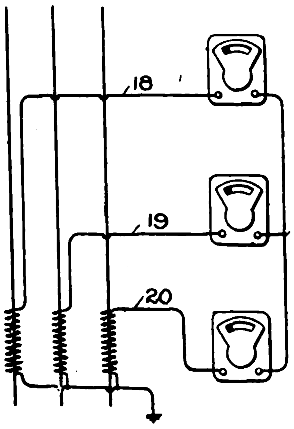


FIG. 4.

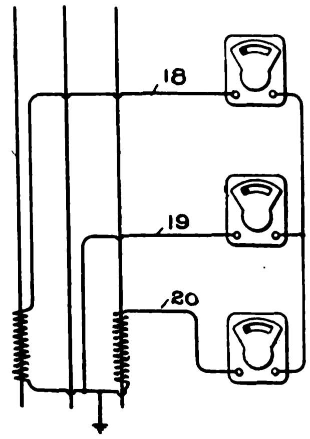


FIG. 5.

NOTES.

Central Station Changes at Cazenovia.—The Union Electric Company, of Cazenovia, N. Y., has sold its plant to the Cazenovia Electric Company, who will rebuild and enlarge the plant.

Electric Ore Hoists.—It is reported that an electric power plant is to be established on the Pennsylvania docks at Ashtabula Harbor, by means of which the fast-hoist ore-handling machines will be operated. It is stated that this will be the first electric plant ever installed for the operation of ore machines on the docks of the great lakes, which, if true, indicates that somebody has been in a comatose condition for several years.

The Engineering Record.—This well-known periodical, which has been brought up to a high plane of usefulness by its founder and editor, Mr. Henry C. Meyer, has been bought by the McGraw Publishing Company, Mr. Meyer having decided to retire from active business after a quarter of a century of notable and successful engineering journalism. The paper will continue to have the benefit of Mr. Meyer's ripe experience and sound judgment, he having consented to act in an advisory capacity with the new management.

Consolidation in California.—According to the daily press, several electric light and power companies in Southern California are to be consolidated. The principal plants which will be included in a new company are those at Los Angeles, Pasadena, Santa Anna, and Redlands. The authorized capital stock of the new company will, it is said, be $10,000,000. The present capacity of the plants which are to be combined is 120,000 horse-power. This is to be increased to four times its present power. It is expected that some of the additional power will come from the Kern River and the Santa Anna Cañon, and it will be distributed of course by transmission lines. This appears to be a new version of the developments projected by the Los Angeles Edison Company, as outlined in the September number of this paper.

A Large Water-Power Plant Projected in Georgia.—An important Southern hydraulic-electric power transmission plant has been projected by Eastern capitalists, the site of the proposed power house being about fifteen miles from Atlanta, Ga. It is contemplated constructing a dam across the Chattahoochie River and erecting a generating station at the dam. It is expected that an equipment capable of 6,000 horse-power will be installed at first and that the plant will ultimately be increased to 14,000 horse-power. The Atlanta Water & Electric Power Company has been incorporated for the purpose of carrying the project through, and it is announced that the electrical equipment will be designed and installed by Westinghouse, Church, Kerr & Company. The generators are to be 60-cycle machines with a terminal e. m. f. of 2200 volts, which will be raised to 22,000 volts for transmission to Atlanta and other distant points. A large amount of power will be furnished at the generator voltage to manufacturing concerns located near by.

Using 133-cycle Single-Phase Motors on 60 Cycles.—Users of high-frequency, single-phase motors will be interested in the procedure adopted by the Memphis (Tenn.) Electric Light & Power Company with regard to single-phase motors operating on its system when the frequency of the system was changed from 133 to 60 cycles. The connections of the transformers which supplied the motors were changed so as to reduce the secondary e. m. f. to one-half of its former value; the pulleys were changed to accord with the new speed which, of course, is somewhat less than one-half the original speed; and the automatic device which short-circuits the commutator when the machine approaches normal speed was modified to conform to the reduced speed. The reduction of voltage, of course, kept the magnetic densities almost unchanged, the frequency having been reduced more than one-half. The change of frequency was made all over the city one morning, without providing single-phase motor customers with relay service, and all of the single-phase motors were in operation again before the close of the day.

Stanley Transformer Patent Decision.—Judge Lacombe, of the United States Circuit Court of the Southern District of New York, on November 17 handed down an important decision denying a motion for a preliminary injunction applied for under a decision written by himself in the case of the Saranac Electric Light Company, and handed down from the Court of Appeals on January 14, 1902. In this latter decision the defendant maintained that the Stanley claims indicated no invention, but the court held that if these claims were read in the light of explanatory matter included in the specifications and denominated the "Stanley rule," the patent did cover an invention. The court's statement of the Stanley rule was as follows: "It says you may determine the proper length of the primary coil by connecting the transformer in circuit with the dynamo with which it is to be used, and then winding on wire until the loss indicated by the formula $C^2 R$, with the secondary circuit open, equals a certain loss of energy." The decision in the present case is to the effect that while in the former case there was no proof that the defendant's transformer was so constructed as actually to use the so-called Stanley rule in determining the length of wire in the primary coil, it did appear that the length used was substantially the length that would have resulted from the application of the rule. The evidence in the present case, however, is much more specific as to the length of wire in the primary coil; and in view of the repeated and concurrent testimony of the many experts called by the defendant, it cannot be held that the length of wire in the primary coil is substantially the same as it would be if such length were determined by the Stanley rule. Judge Lacombe concluded by saying that if the length be not substantially the same, we seem to have the very exception suggested in the opinion of the Court of Appeals: "Some other length covered by the language of the claim but not of the rule, would fall outside of the claim." The decision is that infringement is not shown, and the motion for injunction was denied. The decision is to be appealed.

Great Water-Power Plant at Sault Ste. Marie, Michigan.—The hydraulic construction and equipment of the mammoth water-power plant of the Michigan Lake Superior Power Company, at Sault Ste. Marie, Mich., is now almost completed and the electrical apparatus is being installed. This is one of the many undertakings which the Clergue Syndicate has inaugurated at Sault Ste. Marie in the past five years. This water-power plant will be exceeded in size only by that at Niagara. The waters from Lake Superior, in falling to the level of the St. Mary River, have a drop of about 20 feet, though the head varies with the variation in level of Lake Superior and Lakes Michigan and Huron, so that it is sometimes as high as 21 feet, and sometimes less than 17 feet. The water is taken from Lake Superior at a point just west of the United States ship canal, and a canal is cut through the city of Sault Ste. Marie to a point on the St. Mary River, below the rapids. The canal is 2¼ miles long. It is timber-lined below the water line, and faced with stone masonry along the banks above the water line. The average depth of the water is 23 feet, and the width at the water line is 214 feet. At the lower end of the canal, it widens into a forebay, from which the water passes to the power house and on into the river. The power house foundation forms the dam and is 1,368 feet long. There are 80 generating units, driven by four Webster-Camp-Lane turbines mounted horizontally on the same shaft. The water enters these turbines directly from the forebay, and each pair discharges into a draft tube. The horizontal shaft from the turbines extends through a steel bulk head into the generator room.

Half of the output of the power house has been contracted for by the Union Carbide Company, which company will have for its use forty-two single-phase 60-cycle 90-volt Westinghouse alternators of 400 kilowatts output each. The Michigan Lake Superior Power Company will put in thirty-three Stanley 2,400-volt three-phase 30-cycle alternators to generate current for sale to various industries which, it is expected, will locate at the "Soo." The remaining turbine units will drive direct-current exciters. The total capacity of the power house will be 32,000 kilowatts. In order to handle the units in about half of the power house with one switch-board, electrically-controlled switches will be put in, and the switchboard proper will have only pilot and instrument circuits of low voltage on it. The chief engineer of the plant, during construction, has been H. von Schon, assisted in the hydraulic work by J. H. Brace. W. Owen Thomas is the electrical engineer.

Pre-Exposition Model Power Plant of the St. Louis Exposition.—The feeling regarding the Machinery Department of the Exposition to be held in 1904 at St. Louis, particularly among the machinery manufacturers who have investigated the subject is evidenced in a practical way by the offerings for the pre-exposition model power plant. In no branch of industry is the prosperity of this country more noticeable than among the builders of boilers, engines, electrical generators and other apparatus for power plants; and this department of the World's Fair has already acquired guarantees for all items necessary to this power plant to an aggregate of over 1,000 kilowatts. These items will be furnished on the exhibit basis, and will constitute the nucleus about which will be built the only operative power plant of the exposition, the exhibits of which will be eligible for award.

This plant is particularly interesting to prospective exhibitors in that it affords an opportunity never offered by any previous exposition. The period of service will exceed two years, three-quarters of the time elapsing before the exposition has been formally opened to the public. The busy manufacturer, ever keen for effective methods of publicity, has been quick to grasp the exceptional opportunities afforded, and it has been through his ready co-operation that the Department of Machinery has been able to accomplish these unprecedented results.

Europe has responded most royally to this offer of the exposition, and Germany has already shipped the first exhibit to be installed upon the exposition grounds. This exhibit consists of a 700-h.p. water-tube boiler of the Durr marine type. German boiler manufacturers will be further represented by Fried. Krupp, with a Schulz marine type water-tube boiler, and L. & C. Steinmuller, with a water-tube boiler of the stationary type. French boiler makers will send units from two of their most noted marine-type water-tube boilers, and England will send two marine and several stationary water-tube boilers.

The Clonbrock Steam Boiler Company will send two units aggregating 550 horse-power capacity. The DeLaval Steam Turbine Company will install two 300-h.p. steam turbines direct connected to twin type generators; the Buffalo Forge Company and the Stanley Electric Manufacturing Company will furnish the two members of a 200-k.w. direct-connected generating set, the Skinner Engine Company and the Warren Electric Manufacturing Company the members of a 150-k.w. direct-connected unit. These units will deliver alternating current for police lighting about the grounds during the period prior to the opening of the exposition.

All of the machinery in this "model" plant will be housed in most attractive quarters, and the installation which has already begun will continue, according to the deliveries promised, until March, 1903, when the plant will be complete. The pre-exposition plant will be merged with the large exhibitors' power plant to be located on the main floor of the Machinery Building.

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The American Electrician has a larger paid subscription list than any other electrical journal in the world.

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Standard Voltages.

As we have pointed out before, the standard direct-current voltages in this country are unsatisfactory in several respects. The adoption of 110 volts as the standard for constant-potential work years ago, whether with a view to sustaining a transmission loss of about 10 per cent. and delivering 100 volts at the lamps, or because Mr. Edison's early experiments led him to believe this to be the highest voltage that lamps could be made to stand, had no drawback. At that time there was no standard higher voltage with which the lamp voltage could have been made commensurate, and the latter might have been put at 109¼, or any other peculiar figure, without entailing commercial inconvenience.

To-day, the persistance of the old standard is not only unnecessary, but illogical and highly inconvenient. For example, dynamo and motor frames having a given output capacity when wound for 110 or 220 volts cannot be wound for the same capacity at 500 volts on the same basis of rating, unless they are large enough to permit the use of rectangular wire or bar conductors. Two dynamos built to deliver 220 volts at the load cannot be operated on a three-wire 500-volt system without being speeded up about 14 per cent., and, conversely, a 500-volt motor cannot be operated with normal efficiency on the outer wires of a three-wire system that is worked at 220 volts on each side. The latter disadvantages, however, are not of such great importance now that three-wire circuits are so frequently supplied at the outer wires only and balanced by special means.

The fact that many builders are rating dynamos at 125 and 250 volts does not improve the situation, as these voltages are incommensurate with the full-load terminal e. m. f. of the so-called 500-volt machine. There does not appear to be any important reason why both of the higher standard load voltages should not be made even multiples of the lowest one and that one raised appreciably above 110 volts, the terminal e. m. fs. of the generators to be made as much higher as one may desire, to compensate for line losses, and railway generators to be given extra heavy series windings. Innumerable small advantages and several of respectable magnitude would accrue from the adoption of such a plan.

The standard voltages for low potential alternating-current circuits are also irrational in some respects, as well as being unnecessarily plentiful. We have 50 and several of its multiples, on the one hand, and 52 and several of its multiples on the other; the latter set of standards presumably being intended to provide for drop in secondary circuits. It is obvious that one of these two sets of standards, no matter which, is superfluous, and that the maintenance of both is absurd. Moreover, alternating-current voltages should be identical with direct-current voltages of the same order of magnitude, so that incandescent lamps suitable for one will be suitable also for the other.

In view of the state of the electric lighting art, there appears to be no real necessity for using a commercial voltage under 150, and we are strongly of the opinion that, despite the temporary inconvenience involved, a change of the standards to 150, 300 and 600 volts would be of considerable advantage to the industry. Probably the most important result of such a change would be to increase the radius of activity for direct-current plants by 100 per cent., without increasing the line losses or altering existing lines. Another important benefit would be derived in that the discrepancy between circuit voltages at points wide apart could be reduced greatly, without excessive expense for copper. Alternating-current secondary voltages being changed to correspond, the primary voltages at the transformers would naturally be made 1,500 and 3,000 instead of 1,000 and 2,000, and the lower figure would be sufficiently high in many plants where 2,000 is now used only because 1,000 is not quite high enough for economy.

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Complex Railway Systems.

Developments and proposed developments in the electric railway field are multiplying at a somewhat startling rate, and an impartial consideration of some of the new systems undeniably creates the impression that novelty is their chief merit. It does not seem justifiable, from a practical engineering standpoint, to load a railway car with several sets of apparatus, each of the full power required by the car, and to transform energy several times in relatively small quantities. Before saying more, we wish to disclaim emphatically any obstructive bent; no one hails a prospect of improvement in any branch of the electrical industry with more sincere enthusiasm than the American Electrician. But we are convinced that real progress in the railway branch of the art does not lie along the lines followed by Mr. Heilmann, of locomotive fame, or any similar lines. It is not necessarily progressive to devise a complicated system involving multiplex energy conversions and make it operate by dint of extraordinary effort in working out perplexing details. The real path of progress rather points in the direction of achieving difficult results by relatively simple means; the new series motor alternating-current system, for example, will be an exponent of this sort of progress if it be demonstarted a complete success commercially.

The experience with induction motors in Europe would seem to indicate that this type of machine is susceptible of practical application to railway service; it has been so applied on the other side of the Atlantic for several years, and its advocates claim that the results are commercially satisfactory. Polyphase motors, of course, involve an objectionable multiplicity of delivery rails or wires, and there appears to be a lack of confidence in the possibilities of single-phase induction motors (with phase-splitting apparatus) for railway work. But whatever the merits or disadvantages of the induction motor may be, it is perfectly feasible to drive a train with direct-current motors supplied from the commutator end of a single-phase rotary converter carried on the train and kept in motion continuously during a "run." Such a system obviously would be much simpler than the Leonard system described elsewhere in this number, and could be made amply flexible for any railroad service that has thus far developed. The complex system proposed by Mr. Leonard would give as beautiful and complete control of the train as could possibly be devised, and the method of control of which this is an elaboration has a recognized place in direct-current engineering; but the application of these methods to railway service would appear to be very much like putting in an automatic cut-off engine to drive a country saw-mill.

Opposition to the Metric System.

It is really difficult to read without extreme impatience the alleged arguments advanced by some of the opponents of the metric system. A fair-minded person is willing to look on both sides of an important question such as this one, but your real, enthusiastic adherent to the present ridiculous hodge-podge of American weight and measure standards is above any such petty considerations as merit in the argument of "the other fellow"; all he looks for is an opening for the wedge of vehement criticism. This is doubtless true also of many metric system advocates, but not of those who have thus far established any claim to public recognition; whereas some of the prominent enemies of the system appear to have no better ground for their attitude than a reluctance to spend money, a bad temper, and a few absolutely immaterial inconsistencies on the part of their opponents.

For example, the author of a paper scheduled to be read before the American Society of Mechanical Engineers during the first week of the current month seems to think he has made a tremendous point by showing that the karat is the standard of weight for gems all over the world, in correction of a statement made by Mr. Troemner before the Congressional committee to the effect that he knew of no other system of standards in use by jewelers who use the metric system. Just why Mr. Troemner's failure to include the method of weighing gems in his consideration of the subject should be deemed an argument against the metric system is utterly obscure; and to an open-minded man the fact that there is a solitary universal standard of weight for precious stones is a strong and logical reason for adopting the system of weights and measures for physical and industrial purposes that comes nearest to being universal—the metric system. In the same paper there are several other so-called arguments of the same character, probably the most illogical of which is to the effect that in several countries where the metric system is the legal standard, English and American measurements are also found in certain lines because the English and American products in those lines, made to English and American standards, are preferable to any others; hence, the metric system is a failure there!

In previous discussions of this question, we have disavowed any infatuation with the metric system, and we are still entirely unbiased regarding its adoption in this country. Personal preferences and prejudiced opinions have nothing whatever to do with the case legitimately; the bald facts are the only factors worthy of consideration. These facts are (1) the metric system gives linear, square and cubic standards that are commensurate with each other and are interconvertible by merely moving a decimal point; (2) it is the recognized standard of all branches of science, except astronomy, throughout the civilized world; (3) it is the common legal standard of a greater number of important nations than any other system; (4) there is nothing in the system that militates against the reduction of a unit by repeated halving, which appears to be so precious to its antagonists. The sooner the advocates and opponents of its adoption get down to a sensible consideration of the matter on this basis, and stop childish efforts at picking flaws each in the other's unessential statements, the sooner will a rational conclusion be reached.

Cast Steel.

The merit of American methods and American industrial products is a subject concerning which we entertain opinions favorable to the verge of partisanship, but regard for the truth compels the admission that the comparison of American cast steel with that produced in Europe is an uncomfortable process. It is a matter of common knowledge in engineering circles that the buyer of cast steel made in this country has to take what he can get rather than what he actually wants. When a core-box of any degree of intricacy is offered to a steel founder, he throws up his hands in dismay; and if the customer is not too important in the industrial field, the founder intimates that he doesn't care for his—the customer's—business anyhow, if it runs that way. Angles must be filleted to an absurd radius, lugs of a size less than one capable of sustaining a ton or so may "come" on the casting and may not, air pockets or blow holes occur with disconcerting frequency and almost invariably in that section of the casting where they do the most harm. In short, the production of sound steel castings of small bulk and accurate contour appears to be accidental, if it ever occurs at all.

This is not true in the best European foundries. We have seen French steel castings, for example, that are amazingly true to pattern, thin-walled and sound, with cored recesses of a character that would doubtless be considered absolutely prohibitive in the United States. We do not know enough of the practical details of steel moulding to form any opinion as to the explanation of these facts; they exist, however, unfortunately beyond dispute, and their existence is without apparent justification. It is certainly true that the market here for fine steel castings is sufficiently large and attractive to warrant the most exhaustive experimentation and expensive plant equipment that one can conceive to be necessary for the production of such castings. It is true also that there is no lack of brains and energy in the American metallurgical industry. These two well-known facts are precisely the things that render it impossible to understand why foreign steel castings are so much superior to ours in the particulars mentioned.

CONSTRUCTION OF A JUMP SPARK IGNITION COIL AND CONDENSER.

BY JAMES F. HOBART.

The occasion demanded apparatus for the ignition of charges of gasoline and air in four cylinders of a hydrocarbon engine. The attempt was made to do the work with a single induction coil, the igniting current being switched from one circuit to another by means of a rotating distributor similar in action to that shown by Fig. 1. The working of this device was as follows: A ring *B*, was made fast to the face of a revolving block of wood *A*, which, in the experimental stage was attached directly to the engine shaft. The primary current was sent through the ring *B*, by means of the brushes *E* and *F*. If it had been intended to use the device in this form, it would answer exactly as well to have connected the battery direct to the primary coil, without taking the primary current to the disc at all. A single contact, *G*, was then placed upon *A*, and well insulated by distance as well as material, from all other conducting parts of the apparatus. A collecting ring and brush *F*, served to convey current from the secondary coil to contact *G*, which, as it revolved with the engine shaft, came into contact, one after the other, with C_1, C_2, C_3 and C_4. The remaining end of the secondary wire was connected to the several spark plugs I_1, I_2, I_3, I_4. In actual connection on the engine, this terminal of the secondary coil was grounded upon the engine frame. The spark plugs being screwed into the engine cylinders, completed the electrical circuits in principle as shown in the engraving.

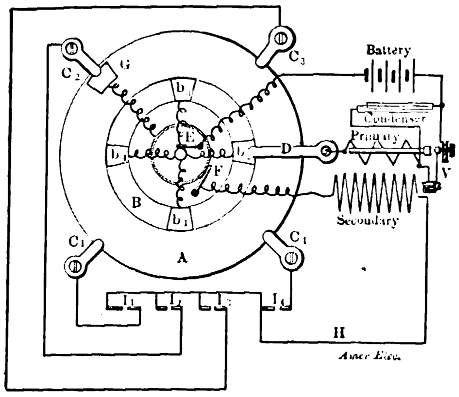

FIG. I.—DISTRIBUTION OF SECONDARY CURRENT.

A regular induction coil was used in this experiment, the condenser being contained in the base and the usual vibrator being operated by the magnetism of the core. As first tried, the interrupter ran all the time, consequently the secondary wiring was under tension continually. The result was a dismal failure, and the arrangement is described here merely to enable others to profit by the experience and avoid a duplication of it. The ignition point varied many degrees of a revolution—varied so much that it was perfectly unreliable. The reason was found in the irregular jumping of the secondary spark between the *C* brushes and the plate *G*. Sometimes the spark would pass between them when nearly half an inch apart, again they would touch before the spark passed, hence the unreliability of the ignition. To cure the trouble, the ring *B* was cut into four segments b_1, b_2, b_3, and b_4. The segments were connected to the ring and brush *E*, as shown. By adjusting the *C*, and *b*, segments in such a manner that contact was made at *C*, before it occurred at b, the secondary spark was stopped on the disc *A*, but the ignition still continued to be unreliable. This time, the cause was found to be in the interrupter *I*, which sometimes would act quickly when contact occurred on any of the *b* strips, but sometimes would be slow of acting, thus delaying the ignition. This failure resulted in the construction of a separate coil for each ignition, and a separate condenser for each coil.

The core of each coil consists of No. 16 soft iron wire, cut into pieces 5 inches long. These must be straightened, which may be accomplished by rolling them on a surface plate with a bit of hard wood. A smooth wooden surface will answer to roll upon, but the iron plate is much the best for the purpose. To make up a core, a bit of brass tubing about ¾ inch in diameter and 4 inches long is filled with the straightened wires, as many being put in as possible. After the tube is seemingly full of wires, a little rolling of the ends of the wires extending beyond the tube will make room for more wires. When the limit is reached, the end of the core protruding from the tube is neatly bound with friction tape, up to the tube, the latter is then pushed along and more tape wound on, until the tube is entirely off the core and replaced by a neat layer of tape. The ends of the core are then smoothed up on an emery wheel. The primary coil consists of six layers of No. 22 double cotton-covered magnet wire, well taped. The secondary winding is of No. 36 double cotton-covered wire, made in two sections of 36 layers each, side by side, each section being 2 inches wide parallel with the core. In the coils built by the writer the primary winding consisted of about 600 turns of wire and the secondary contained 9,216 turns of wire, total, a ratio of about 1 to 15.3.

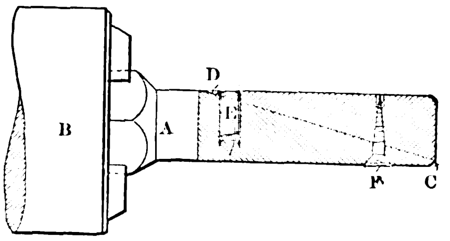

FIG. 2.—COIL MANDREL.

The secondary coils may be wound on a form made as shown by Fig. 2. A bit of oak wood *A*, is caught in the jaws of a lathe chuck *B*, and turned to 1⅛ inches in diameter; then fitted with a screw *F*, and a pin *E*, and cut diagonally to the line *C—D*. To make a good job, the wood should be turned nearly to size, then screwed, pinned and sawn, after which it is put in the lathe again and trued up to size.

The winding of the coil was done as shown by Fig. 3. Strips of close texture linen paper were dipped in melted paraffin, kept as hot as possible without vaporizing, then held in a vessel just above the melted wax, where it was very hot, until they ceased to drip; then they were hung up to harden. The pieces of paper must be very carefully gone over before they are dipped, and all pieces containing holes or other imperfections thrown out. Any surplus wax remaining on the paper after drying should be removed by scraping with a dull knife.

The paper after dipping is cut into strips 2½ inches wide, and of any convenient length. A bit of plain manilla paper is wound around the mandrel, *A*, then two thicknesses of paraffined paper put on and fixed by momentary heating over an alcohol lamp so as to stick the paraffined surfaces together. The No. 36 wire should then be doubled upon itself three times for about 2 feet, making a four-strand piece of that length. The inner ends are soldered to the main wire after a single turn has been made on the mandrel, thus securing an inner end consisting of four wires which can not pull directly upon the main wire when the strain of winding comes upon them.

The piece of brass, *C*, is to be used as a gauge in starting each and finishing layer of wire. Both ends of the gauge are made alike, so there can be no mistake made in using it. The winding may be done by the ordinary rod feed of a lathe adjusted to give a pitch of 64 turns to one inch travel of the lathe carriage, which should be right for the wire to be used. A bit of brass rod *I*, is drilled to receive the piece of copper tube, *H*. Through the tube, the wire is threaded from a coil placed on a vertical spindle at least two feet distant from the lathe; the use of a vertical spindle allows the weight of wire coil and spool to act as a brake to a slight tension on the wire. The rod I is clamped in tool-post, *J*, of the lathe, and adjusted to allow the wire to wind properly upon the coil.

After one layer has been wound on—and a little care will be necessary to stop the lathe at just the right point—the reverse gear in the headstock of the lathe is thrown over, and a piece of the paraffined paper slipped over the layer and under the taut wire. Care must be taken to have the strip of paper reach *exactly* around the coil, butting the ends without a lap or gap, and a turn of wire must be wound carefully around to hold the paper in place, as shown at *E*.

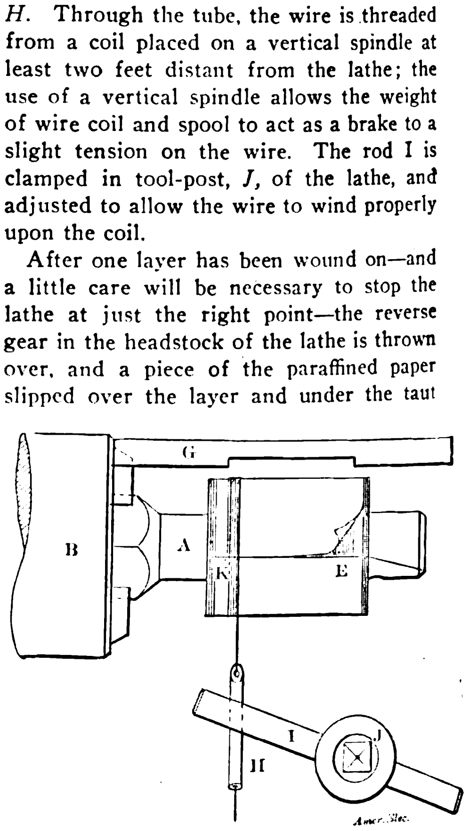

FIG. 3.—METHOD OF WINDING A COIL.

At first, a rubber band may be slipped upon the coil to hold the paper in place; then the wire may be wound close up to the band, the latter removed and the winding finished. After a little practice the rubber band will be found unnecessary.

No movement of the carriage is made when the direction of winding is changed, the simple reversing in the headstock being all that is necessary; the taking up of the slight loss motion between the rod and the apron will usually be just sufficient to allow the reversing of direction in the coil winding. The winding is continued with frequent tests for continuity and insulation, until 36 layers of wire have been put upon the coil. This should make the secondary coil almost exactly twice the diameter of the primary coil.

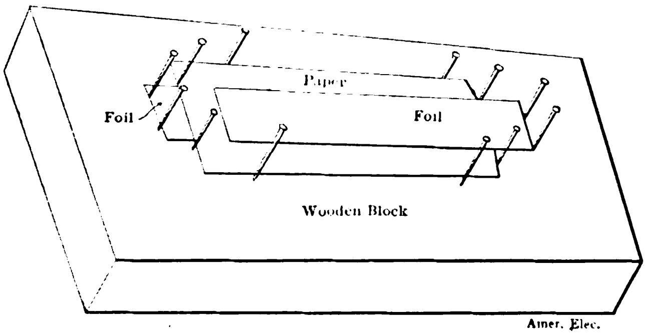

FIG. 4.—JIG FOR ASSEMBLING CONDENSER.

The last turn of wire is not soldered. A bit of paraffin should be squeezed upon the wire, a couple of wraps of manilla paper given to the outside of the coil, and the wire cut off, leaving about six inches of free end. It is less objectionable to take chances of having to pull off another turn of wire for an outer end, in case of breakage, than to solder the last turn and then have to dig out a new end when the old one gets broken off. The coils should be thoroughly steeped in hot paraffin, being allowed to remain therein for at least one hour, and to remain in the vessel after heat is withdrawn until the wax becomes almost cold. Then the coils may be removed and the superfluous wax scraped off. Each coil, both primary and secondary, should then be closely wrapped in very thin sheet rubber of ample length and breadth to protect them, the strips for the primary coil extending 2 inches beyond the ends, and those for the secondary coils extending one inch over each end. The two secondary sections are then slipped over the primary, care being taken to connect the two coils together so that the effect of a continuous coil is obtained. If the coils are connected wrong, the effect of one section of the secondary winding would be to neutralize the effect of the other and no spark would be obtainable. A little care in winding the secondaries exactly alike—beginning them at the same end—and a final test of sparking before the coils are closed up, will prevent a good deal of future trouble in this respect.

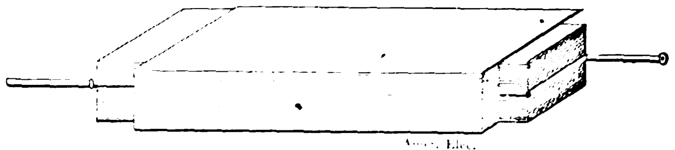

FIG. 6.—CONDENSER.

A condenser suitable for operation in conjunction with this coil may be made as follows: The tin-foil sheets constituting the condenser plates are 3 ins. by 8 ins. in size, and 80 of them will be required. These are assembled in alternation with thin sheets of linen paper, 4 ins. by 8 ins., after the latter have been thoroughly paraffined. In order to accomplish this, the paper slips are dipped one at a time into melted paraffine, which must be kept as hot as possible without smoking. As fast as the slips are soaked with paraffine, they are hung up by a pin stuck through the extreme corner of each sheet and allowed to cool. After cooling any superfluous wax is scraped off by means of a very dull knife, or a strip of square-edged thin steel, the paper being laid on a true, smooth, hard surface during the scraping. Before paraffining the paper, each slip should be closely scrutinized for pin holes, irregular thickness and traces of metallic oxides; any slip that is not plainly free from all of these imperfections should be thrown out.

The work of assembling the sheets of paper and tinfoil will be immensely facilitated by the use of a simple jig, such as that illustrated in Fig. 4. This is simply a piece of board into which are driven wire nails so located as to keep the strips in alignment during the building up. The strips of foil are staggered, as indicated in the engraving; one strip projects at the left-hand end of the "nest," the next one at the right-hand end, and so on. None of the foil slips must touch each other except at the projecting ends, and these ends should extend about half an inch beyond the ends of the sheets of paraffined paper.

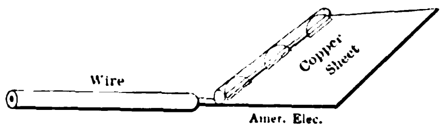

FIG. 5.—COPPER CONNECTOR.

After 40 of the foil slips have been put in place in the jig, a copper connector should be laid on top of the projecting leaves at each end of the condenser, and the remaining 40 sheets built up on top of these. Fig. 5 illustrates one of these connectors, which consists merely of a sheet of copper with one edge rolled around and soldered to the end of a piece of No. 12 rubber-covered copper wire. The flat part of the copper sheet should measure ½ in. by 3 ins. after the wire has been soldered in place.

When the sheets are all assembled, they should be squeezed down tight in an ordinary screw letter press, and tested for insulation. A test between the two terminals should show an insulation resistance of at least a megohm. The projecting ends should, of course, be tightly clamped together during the test, and if the condenser shows too low resistance it must be dismantled and the paper sheets inspected rigorously for punctures or other indications of imperfection. If it tests up all right, then the projecting foil ends may be melted down solid and soldered to the connector at each end of the group.

As four coils and condensers of the kind here described were used in a group, no vibrator was used, the primary circuits of the coils being closed in proper sequence by a commutator driven by the gas engine. Any one having sufficient knowledge and skill to build this coil and condenser will be able, however, to make a suitable vibrator. It is scarcely necessary to add that the condenser should preferably be located within a wooden box, and the latter filled with paraffine. The induction coil and vibrator are preferably mounted on this box.

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Fog Boxes for High-Voltage Insulators.—Mr. J. J. Davis, superintendent of the United Electric Gas and Power Company, which owns a number of plants on the Pacific coast, offers some interesting information regarding experiences with the effect of dust and sea-fog on high-tension insulators. The power house at Santa Monica is located directly on the sea beach, and from there a 22,000-volt line supplies a number of small towns with light and power. The pole line for several miles of its distance is either directly on the coast or but a short distance back from it. Ever since the installation of this high-tension line, the company has experienced the greatest difficulty from current leaking over the surface of the insulators and burning off the pins. This was caused by fogs, which are very thick along this coast. It was found that the line worked perfectly in wet weather, but in dry weather dust would accumulate under the bell of the insulator, and in time of fog, the moist atmosphere would pass under the insulators depositing moisture on the dust, which would form a sort of paste, and so establish a sufficiently low resistance path, so that the high-voltage current would flash across. In a short time the pins would burn off, with the natural result that the wire dropping on the cross-arm would burn the cross-arm off, and ultimately swing against the pole, burning it off. The company tried many schemes to overcome this serious difficulty before they hit upon the novel device of fencing in the pins and glass. This new arrangement has been shown by practical tests to have completely overcome the leakage, and so prevent the burning off of the pins. The fog box is made of one-inch redwood, 12 inches square, and 4¼ inches deep. It has in its top a round hole 10 inches in diameter, which leaves about 1½ inches all around the outer edge of the insulators. The boxes come up within two inches of the wire, and are mounted on the cross-arm. Apparently, they keep the dust and fog from drifting in under the bells of the insulators.

TELEPHONE ENGINEERING.

BY F. J. DOMMERQUE.

POLE FIXTURES.

Cross-arms are almost invariably made of wood, iron cross-arms being used only for supporting aerial cables. Long-leaf yellow pine is the best wood grown in this country from which to make cross-arms. The lumber should be free from all knots and imperfections, with a fine grain and sound heart. The cross-arms should be sawed from this and kiln-dried as thoroughly as possible, after which they should be given two coats of good waterproof paint. A reddish-brown metallic paint is generally used.

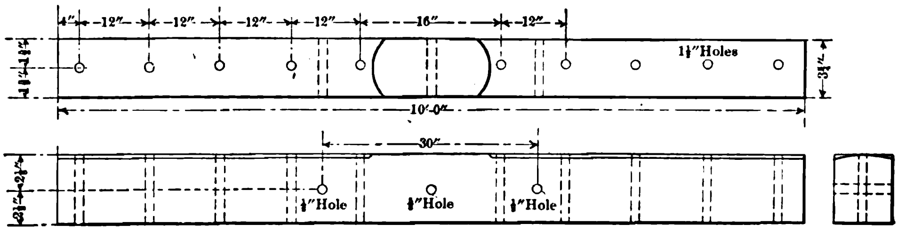


FIG. I.—DETAILS OF IO-FT. CROSS-ARM.

Cross-arms range in length from 30 ins. to 10 ft., and the latter measurement should be made the standard. As stated in a previous article, building a 10-ft. pole-line at the beginning prevents all future disputes as to right of way. For house connections, of course, small cross-arms are used advantageously; the present article is intended chiefly to relate to main pole-line construction. The standard 10-ft. cross-arm (Fig. 1) should be 4¼ ins. high and 3¾ ins. thick. The ends should be sawed off square and the two sides should be at right angles to the bottom plane, but the top should be chamfered or rounded to a radius of about 20 inches throughout the whole length of the arm, except 10 inches in the middle, where the arm is to be attached to the pole; there the top should be left perfectly level so as to fit fair and square into the "grain" of the pole. The chamfer serves to form a roof from which the rain and snow may slide off easily.

This cross-arm is bored with ten holes for the ten pins; the holes must be bored to fit the 1½-in. shank of the pin well; the holes to be along the center of the arm and spaced 12 ins. apart, center to center, except at the middle where the arm sets into the grain; there 16 ins. should be left between the two holes nearest the pole. This leaves 4 ins. from the centers of the last holes to the ends.

The cross-arms are attached to the pole by two ½-in. lag screws or better by one ⅝-in. carriage bolt, the hole for this being drilled through the middle of the arm. If lag screws are used they should be 9 ins. long, and their thread should be cut so as to allow of their being driven part of the way home; they should be staggered so as not to weaken the arm too much. If carriage bolts are used, they should be long enough to reach through the pole and take a nut and one or two washers at the other end. Two more holes are to be drilled in the cross-arm for attaching the braces. These holes are to be on 30-in. centers, 15 ins. each way from the center of the pole, and large enough to allow a ½-in. carriage bolt to pass. All holes should be bored sharp and clean and so as to give a driving fit for the bolts, which will prevent moisture from entering.

In places where there is no fear of sleet loading the wires nor of high winds—in short, where there is never a chance of unfavorable weather conditions—a lighter 10-pine cross-arm may answer the purpose. Its length may be 8½ ft., its height 3¾ ins., and its thickness 2¾ ins.; distance between pine hole centers 10 ins., except at the middle, where 16 ins. will be required, leaving 3 ins. from the center of the last pin to the end of the arm. The pins used with this arm are only 1¼ ins. diameter of shank; the lag screws are only 7 ins. long. For such cross-arms common pine is mostly used. At the end of a pole line, shorter and heavier cross-arms are used, with the pins set 9 ins. apart. Fig. 2 shows such cross-arms.

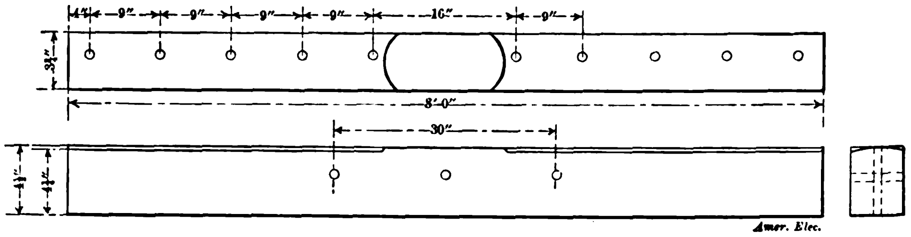


FIG. 2.—DETAILS OF 8-FT. CROSS-ARM.

Alley-arms, as the name suggests, are used in alleys and are therefore encountered almost exclusively in cities. They are attached to the pole at one end, carrying all of the wires on one side of the pole. These should not carry less than ten pins, but they may be somewhat shorter than the standard cross-arm. The advantage of alley cross-arms lies in the ability to avoid crossing private property with the wires, thereby obviating any cause for complaint or damage suits, and also the use of high poles, as there are no houses or barns to be cleared. The alley-arm should always be of long-leafed yellow pine and drilled for 1½-in. pin shanks.

As alley lines are almost invariably located in the rear of high buildings, barns or warehouses, there is not much danger from wind, and it is practical to locate the wires closer to each other than in the case of an ordinary exposed pole line. The holes for the pins, therefore, may be bored only 8 inches apart, center to center, leaving 4 inches from the center of the last hole to the free end of the arm and 26 inches from the center of the nearest hole to the end that is secured to the pole, the arm being 8½ feet long, 4¼ inches high and 3¼ inches thick. The alley-arm is chamfered or rounded on the top exactly like the cross-arm, excepting 10 inches of its length at the pole end. When used for carrying cables, alley-arms are frequently made 4¼ inches thick.

The alley-arm is attached to the pole by a bolt or by two lag screws, and supported by two braces, the same as a standard cross-arm, but as the alley-arm sticks out a good way from the pole and is entirely unbalanced, an additional support is required at the far end. Many forms of support have been thought out for this purpose; the writer will describe only a few of them. This support is commonly called a "knee-brace," and is made of iron; either angle iron, round iron, flat iron or pipe. Fig. 3 shows an alley-arm supported by a knee-brace, which consists of angle iron 1½ in. x 1½ in. x ¼ in., bent at the lower end and punched or drilled for two ½-in. lag screws, the holes being about 6 inches apart. The upper 6 inches of the angle are forged into a pipe so as to fit into the shoe. The shoe is of cast iron and galvanized; the knee-brace is also galvanized, and, in fact, all metal parts used on poles are nowadays galvanized — bolts, screws, braces, etc. Two side extensions fit to the arm between the third and fourth outer pins; a carriage bolt holds the shoe to the arm, passing through holes in the shoe-exten-

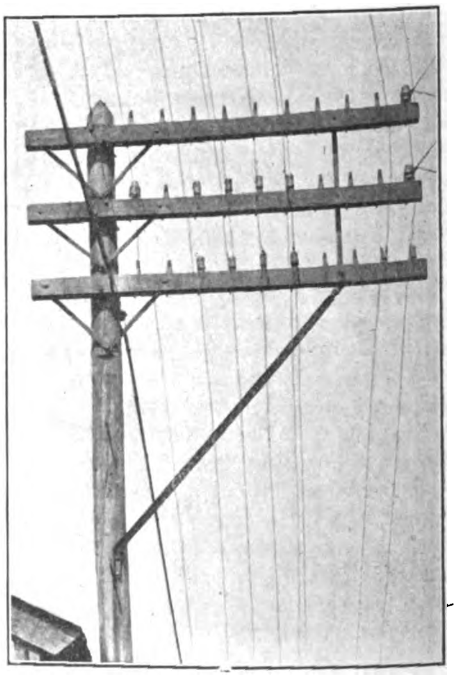


FIG. 3.—ALLEY ARMS.

sions and the arm. The shoe has an extension at the bottom, as shown in Fig. 4, into which the knee-brace fits loosely. This extension has a round hole into which the upper round end of the knee-brace is inserted before the lower end is spiked to the pole; this makes it unnecessary for a lineman to sit on the alley-arm before the knee-brace is attached.

After the knee-brace is inserted into the shoe, it may slip out again when a lineman would rest his foot on it; therefore, the round hole in the shoe is provided with an annular recess, shown in Fig. 4 at *A*, and the knee-brace is provided with a pin, *P*, about ¼ in. thick, which is introduced into the recess of the shoe through a slot *S*. This slot and the pin are set in such a relation that when the pin is slipped into the groove or recess the knee-brace must be given a quarter turn to bring it into the right position to be attached to the side of the pole; thus the pin and recess serve to lock the knee-brace to the arm.

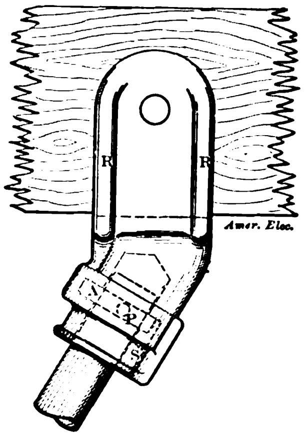


FIG. 4.—SHOE.

As will be noticed in Fig. 4, the shoe is provided on each side with two ribs, *R*, which are there not only for strength, but also to serve as guides for extension braces or straps when more than one alley-arm is used on the pole. If there are two alley-arms, a strap 1½ ins. x ⅜ in. of galvanized iron is set between the ribs on one side of the lower arm and held by the same carriage bolt that holds the shoe; the strap extends to the upper arm, to which it is bolted by another carriage bolt. With three alley-arms, the lowest arm receives one or two straps, one on each side, and the upper arm only one. Very often a single strap is used to tie all three arms together; in that case the strap is attached to one side only. Another form of knee-brace is illustrated in Fig. 5, which needs no further explanation.

Standard 10-pin long-leafed yellow pine cross-arms cost 3½ cents per lineal foot, and last about eighteen years; 10-pin common pine cross-arms are worth the prices given below, and last about six years.

Prices of 2¾ in. x 3¾ in. cross-arms bored for 1¼ in. pins and ½ in. lag-screws, painted two coats of red paint.

2-pin, 30 ins.	$8.12 per 100
4-pin, 42 ins.	11.35 per 100
6-pin, 62 ins.	16.80 per 100
8-pin, 82 ins.	22.21 per 100

Oregon pine has lately come in the market for cross-arms; it lasts up to twenty years. Knee-braces cost from 95 cents to $1.25, according to their greater or less complication; this includes the cost of the shoe also.

As all iron and steel parts used for pole fixtures should be galvanized, it may be opportune to insert here a method of testing. The piece to be tested is immersed four times in succession in a saturated solution of sulphate of copper, each immersion lasting about 70 seconds. If, after this, the piece appears black, the zinc has remained upon it, and it may be used; if copper deposits show, the zinc has come off and the piece should be rejected.

Braces.—There should always be used two braces with each cross-arm; one would be sufficient to keep the cross-arm from turning on the bolt, but would not give the desired rigidity. It has in many cases been deemed advisable to use even four instead of two braces, mostly on poles where the arms are subjected to an extraordinary strain. In such cases the two extra braces are attached to the back of the cross-arm and pole. Fig. 6 shows the method of attaching the braces; *A* and *B* are the ordinarily used braces, and *C* and *D* are the back braces, if such are required. The braces are of galvanized steel, 24 ins. long, 1 in. wide, ¼ in. thick and drilled at one end for a ½-in. lag-screw, and at the other end for a ½-in. carriage bolt, the holes being on 22-in. centers.

The carriage bolts that holds the braces to the arms are 4½ inches long for yellow pine arms and 3¾ inches long for common pine arms. On each side of the arm a galvanized steel washer should be placed, one under the head and one under the nut of the bolt. These washers are round, 1½ inches in diameter and ⅛ inch thick. A galvanized steel fetter drive screw will hold the two braces to the pole; this screw is ½ inch in diameter, from 4 to 5 inches long, and provided with a wood-thread for about three-quarters of its length, so that it may be driven home part of its way. Braces cost $70.00 a thousand, bought in lots of not less than 500. On larger lots there is from 5 to 15 per cent. discount. Carriage bolts, 4½ ins. x ½ in., cost about $3.50 per 100; 3¾ in. x ⅜ in. bolts, cost about $2 per 100. Fetter drive screws cost from $5 to $6 per 100.

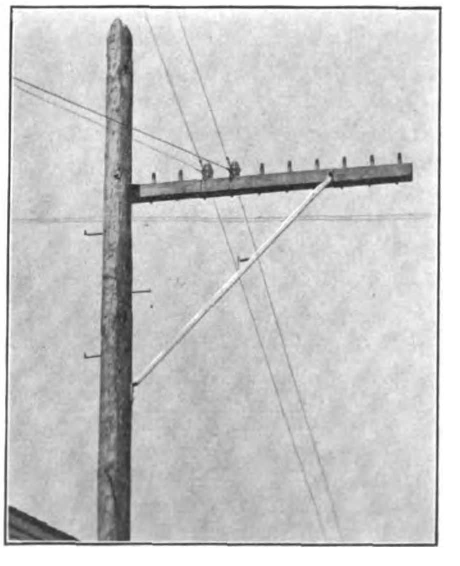


FIG. 5.—ALLEY ARM.

Pins.—The only reliable insulator pin is made of locust, turned from the split wood. Oak pins cost half as much, and are not half as good. At corners of pole lines and places where an extra heavy strain comes on the pins, iron or steel pins have been used; but these are not much of an improvement, if any, upon locust pins, being liable to bend, and of high conductivity. The pin used with the standard 10-ft. arm is 8 inches long, 4 inches being given to the shank (which in this case is 1½ ins. average diameter), 1⅞ ins. to the cone (which is 1⅞ ins. in diameter at its lower end, forming the shoulder against the cross-arm, and 1¼ ins. in diameter at its upper end, where the thread begins), and 2⅛ ins. to the thread, which is cut so as to fit nicely into the insulator. (See Fig. 7.) There are about three threads to the inch, and the thread is cut very nearly square, but not as sharp as it would be in the case of an iron screw-thread.

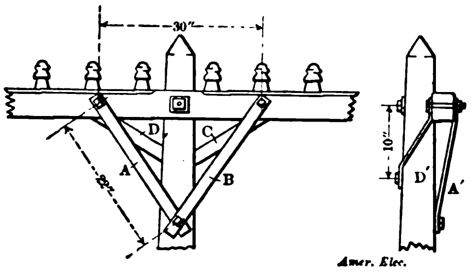


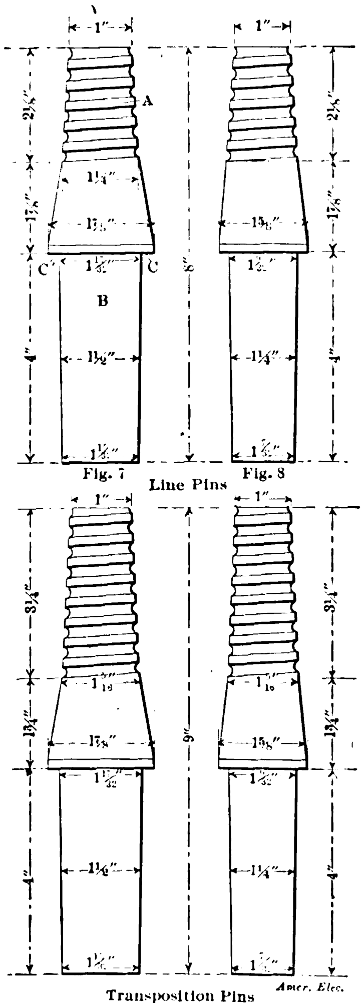
FIG. 6.—METHOD OF BRACING.

The pins for the lighter 8½ ft. cross-arms have the same dimensions lengthwise, but the shank in this case is only 1¼ ins. average diameter and the shoulder 1⅝ ins. (See Fig. 8.) The thread is the same in both cases. The shank is always a little tapered. The pins when delivered should be sound; the thread should be examined, and pins with pieces broken out of the thread should be rejected. The pins are held in the cross-arms by wire nails driven through the side of the arm. Pins should be painted the same as the cross-arm and should be attached to the arms before putting on the pole. The price of 1½-in. locust pins is $16 per 1,000; 1¼-in. oak pins cost $9 per 1,000; 1¼-in. locust pins cost $12 per 1,000, and 1¼-in. oak pins cost $6 per 1,000.

The pins just described are used on straight line work; on long-distance lines where the wires have to be transposed in certain intervals to avoid cross talk, a pin is used that allows of the attachment of a transposition insulator, which consists of two insulators, one on top of the other. The pins used for this purpose differ from the standard pins in the length of the cone, which is in that case 1¾ ins. long, and in the length of the screw thread, which is 3¼ ins. long. (See Figs. 9 and 10.)

Insulators.—The material used for insulators in this country is glass, while European practice favors porcelain; both have their advantages. Porcelain is the better insulator, but it is more expensive than glass, and the glass insulator is commercially preferable in telephone work, the insulation being good enough and the price low. Glass insulators are moulded, and preferably of white or nearly white glass, so as to prevent insects from locating their homes inside the cavities; insects preferring dark spots for such purpose. Green glass is cheaper and probably somewhat stronger, but more opaque. The surface of the glass should be perfectly smooth so as to let the water run off easily and prevent soot and dust from collecting. The glass should of course be free from blow-holes, which impair its strength.

The so-called "pony" insulators have found great favor in the telephone field; the pony insulator has a single groove for straight line work and a double groove for transposition lines. The standard or regular pattern of insulator is the heavier one and preferable. Of this type, the double one is used for transpositions. Fig 11 illustrates the single regular insulator, the grooves *A, A'* varying according to size of wire, and Fig. 12 the double one. The types of insulators are many; some have double petticoats, some have teats around the bottom edge; but the pony and the regular or standard are mostly used. Pony insulators range in price from $20 to $25 per 1,000, according to size and quantity. They are shipped in barrels, about 400 in a barrel. Sometimes transposition insulators are made of one piece; then the insulator is provided with two grooves and costs from $65 to $85 per 1,000. Two-piece transposition insulators cost from $103 to $133.50 per 1,000, according to size and quantity.



FIGS. 7, 8, 9 AND 10.

Pole Steps.—There are two sizes of pole steps in use, both being made of galvanized steel. The lighter size is 9-16 in. in diameter and 9 in. long, the heavier one is ⅝ in. in diameter and 10 ins. long. Both have a wood thread cut at one end and are bent over about an inch at the other end so as to prevent the lineman's foot from slipping off. Pole steps are placed on both sides of the pole at right angles to the cross-arms, and staggered; they are spaced on 30-in. centers on each side of the pole. The lowest step in about 10 feet above the surface of the ground. From there down wooden bracket-steps are generally spiked to the pole on 36-in. centers, three on the front and two on the back of the pole. On poles of a very large diameter the steps are placed on only 24-in centers. A 30-ft. pole requires on the average eight pole steps; a 35-ft. pole, eleven; a 40-ft. pole, fourteen; a 45-ft. pole, eighteen; a 50-ft. pole, twenty-two. Pole steps in lots of 500 or less cost $50 per 1,000 for ⅝-in. diameter; $36 for 9-16-in., from which prices there is from 5 to 15 per cent. discount in larger lots.

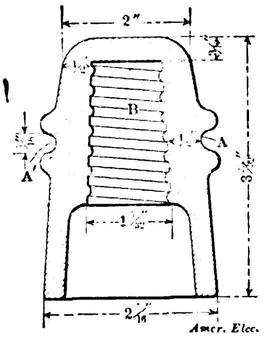


FIG. 11.—SINGLE INSULATOR.

Butt Guards.—On street corners and in streets and alleys where the traffic is heavy, poles are provided with butt guards of sheet iron; these are 3-16 ins. thick and measure 18 ins. up and down and 24 ins. sidewise for large poles, and for small poles 15 ins. and 18 ins. respectively. Usually they come rolled to a diameter of about 14 or 15 inches and can be opened or closed to fit the pole. The holes in them are punched for 20-penny wire nails or spikes, the holes up and down being closer together than those horizontally; each plate requires about two pounds of spikes. Butt guards cost from 50 to 75 cents, according to size. Spikes are sold by the pound.

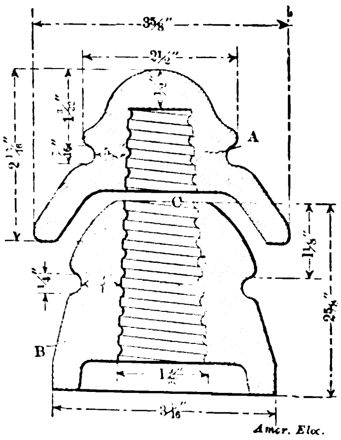


FIG. 12.—DOUBLE INSULATOR.

Protection-strips.—Poles are frequently provided with perpendicular protection-strips, sometimes in addition to butt guards, sometimes without them. The length of the strips varies from 4 feet to 8½ feet. The strips are of galvanized iron 2 inches wide and concaved so as to conform approximately to the rounding shape of the pole. A 30-ft. or 35-ft. pole requires eight protection strips; a 40-ft. pole, nine; a 45-ft. pole, ten; a 50-ft. pole, eleven. The protection strips are not punched for nails, but are attached to the pole by barbed nails driven in along the edge of the strip on about 9-in. centers vertically. From one to two pounds of nails are required, according to the length of the strips and the thickness of the pole. The protection strips cost from $4 to $6 per 100, according to length.

Many telephone companies have attempted to wrap the poles for protection with either iron wire or iron straps, winding the wire in spirals around the pole and using staples in the case of wire and nails in the case of straps for holding. Such protection, however, is objectionable, as in case of a break in the wire or band the ends stick out from the pole and become dangerous to passers-by and also give the poles the appearance of neglect.

SETTING THE VALVES OF A CORLISS ENGINE.

The following instructions will be found useful by those who are in charge of Corliss engines of the ordinary horizontal type. These instructions were originally written to apply to the Eclipse Corliss engine built by Frick & Co., but they are equally applicable to any other engine of the same type, of course.

The Steam and Exhaust Valves. The back valve-chest cover or bonnets should be taken off and upon the bore of each seat will be found a mark which is in line with or coincides with the closing edge of the port for that particular valve-seat, as indicated in Figs. 3 and 4. Upon the end of the valve will also be found a mark running towards the center of the valve; this line coincides with the closing edge of the valve. The exhaust valve controls the port leading into the exhaust passage and not the opening from the cylinder downward. The upper edge of the exhaust port is the closing edge, and the outer edges of the steam ports are the closing edges.

The wrist-plate should next be looked over, and a mark will be found upon its hub; also corresponding marks upon the hub of the wrist-plate bracket, and marks which show the full extent of the motion of the wrist-plate when it is moved back and forth by the eccentric. The wrist-plate should be located exactly central between the four valves, and is so placed in the shop in building the machine; all adjustments are made and the valves properly set, but in taking apart for adjustment the adjustments may have been disturbed and need careful going over before attempting to start the engine for the first time. To test the marks on the wrist-plate hub, connect the eccentric rods and engage or drop the carrier rod upon the wrist-plate stud; then rotate the eccentric upon the shaft, the full extent of its throw or movement each way, and observe if the marks upon the hub of the wrist-plate at full throw agree with the marks upon the bracket; if not, disconnect the box strap of the eccentric rod at the carrier arm and adjust the screw on the stub end by lengthening or shortening, as required, until the marks do agree on both extremes of movement.

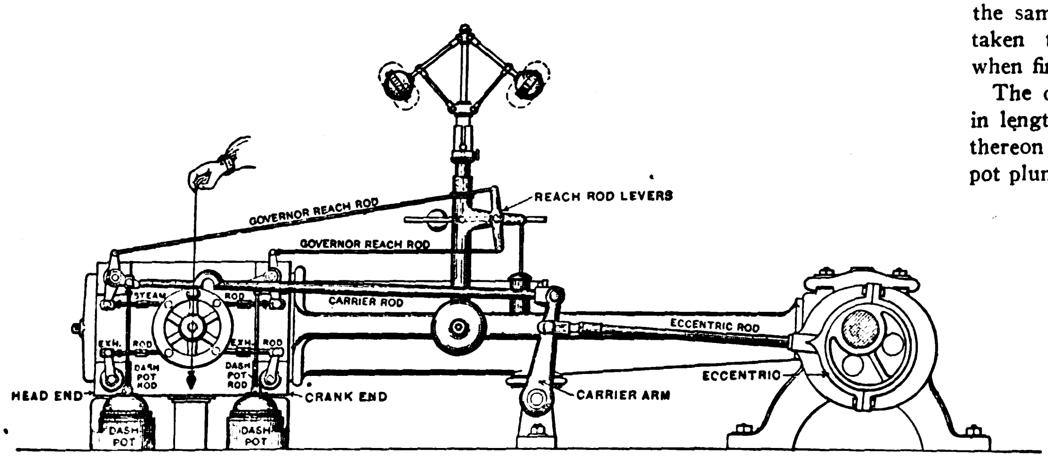


FIG. 1.—SETTING VALVES OF A CORLISS ENGINE.

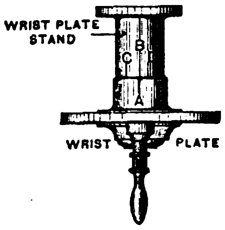


FIG. 2.

To Set the Valves. Place the wrist-plate in the vertical position (see Figs. 1 and 2) at the central mark; turn the valves around in their seats until the steam valves show by the closing edge marks upon their ends by comparison with the port line marks in the seats, that the valve edges lap over or cover the ports ¼ in. for 18-in. bore of engine cylinder, ⅜ in. for 24-in. cylinder, and 7-16 in. for 30-in. cylinder. The exhaust valves should show from 1-16 to ⅛ in. opening, according to the size of the cylinder.

In connecting the wrist-plate, the cut-off latch should first be hooked on the stud or engaged. The plate and valves should be left in their positions and the length of the wrist-plate rods adjusted to suit the distances between the studs. In other words, the wrist-plate and steam and exhaust valve arms should be connected so that the wrist-plate stands at the central mark, or vertical, and the steam and exhaust valve have the proper lap and opening as instructed, the proper amount of steam lap and exhaust opening being determined by the size of the engine.

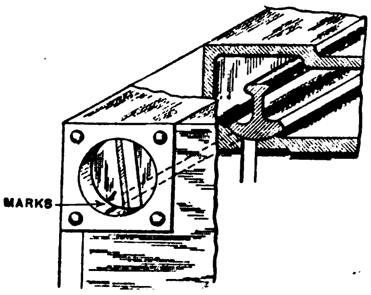


FIG. 3.—ADMISSION VALVE.

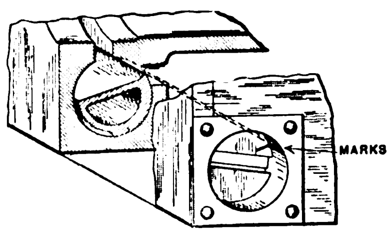


FIG. 4.—EXHAUST VALVE.

To Make Final Adjustments. With the carrier rod hooked upon the wrist plate stud, place the engine upon the center; turn the eccentric upon the shaft (it being loose) in the direction in which the shaft is to turn until it is a little more than at right angles ahead of the crank or until the steam valve on the same end as the piston is just beginning to open, say 1-32 inch. In this position secure the eccentric on the shaft by means of the set screws in the hub. In all cases the steam valves should be hooked up or engaged by the cut-off mechanism. Then turn the engine on the opposite center and see if the steam valve on that end has the same amount of opening; if not, the adjustment can be made by lengthening or shortening the wrist-plate rod attached to this valve.

To Adjust the Cut-off. The governor and connections should be put together properly and the governor should be blocked about half way in the slot; then the reach or cam rod lever should be fastened so that it stands about at right angles to a line drawn midway between the reach rods. The reach rods should then be lengthened or shortened until the cam or trip levers stand vertical or plumb. The governor and connections now occupy the proper relative positions, and it remains to make the exact adjustment and to equalize the cut-off, so that the same amount of steam is admitted at each end of the stroke. Also lower the governor and observe when it is down that the cut-off mechanism does not unhook, but allows steam to be taken at full stroke, after which the engine should be placed at, say, 1-5 of the stroke, which can be done by measuring upon the engine bed guides from each end and turning the engine, with all the parts connected up, until the cross-head is fair with the mark; then slowly raise the governor until the cut-off on the end taking steam trips or unhooks, and to ensure this point being accurately determined it is well to stand by with the hand pressing down upon the dash-pot rod; the governor should be blocked in this position and the cut-off tried on the other stroke the same distance from the end. After a few trials back and forth, and adjustments of the length of the cam-rods, the cut-off can be made to drop at precisely the same point of stroke. Care should be taken to secure everything permanently when finished.

The dash-pot rod should be so adjusted in length that the steam valve arm resting thereon is in such a position when the dash-pot plunger is "home," or at the bottom of the pot that the latch is sure to hook over the latch stud and that the stud lies midway between the latch die and the closing shoulder. This will insure on the one hand the positive engagement of the latch, and on the other hand prevent the shoulder from jamming down upon the latch stud. If the dash-pot rod is too short, the latch will not hook on.

The regulator gag dash-pot is used on Corliss engines to prevent over-sensitiveness of the governor and its response to trivial changes. Only kerosene oil should be used in this pot, and the screw in the piston should be regulated if required to give greater freedom of motion. All parts of the governor should move freely.

Using a steam engine indicator to test the correctness of valve setting is the most approved method known, and should be applied in cases where an indicator is available. In order to adjust the point of cut-off to take the same amount of steam at each end, it is necessary to adjust the cam or reach rods. In order to give more or less steam lead, the wrist-plate rods should be adjusted; lengthening them increases the lap and shortening them gives more lead. The same is true with the exhaust valves; the cushion and release being affected thereby. If the eccentric is properly set, it is not necessary to disturb it in ordinary cases. In closing, stress should be laid upon the necessity of marking everything, so that at a glance one can tell if it has been disturbed.

If the latch dies have a tendency to slip, the latch spring may be at fault; it can be made stronger by twisting the spring stud, bringing more tension against the latch. If the stoppage comes from wear, the latch or stud die should be taken out and turned, thus presenting a new wearing surface; or the edge should be sharpened by applying it to a grindstone. Do not bring any more pressure on the spring than necessary, as when steel dies are in good condition the tension of the spring can be very light.

THE STORAGE BATTERY AS A FACTOR IN SPEED CONTROL.

BY H. B. COHO.

In presenting this paper nothing very novel in the idea of varying the voltage at motor terminals by means of taps to a storage battery, in order to secure speed variation, is claimed. There seem to be some differences of opinion as to the rights of different persons to the multiple voltage system of control, and this opportunity is taken to call attention to the part which the storage battery may play in this important work. All are no doubt quite familiar with the various ways in which batteries may be utilized, and it is the purpose of the author to dwell particularly on a method of using a storage battery, as an auxiliary or independent source of supply, in connection with the operation of printing presses.

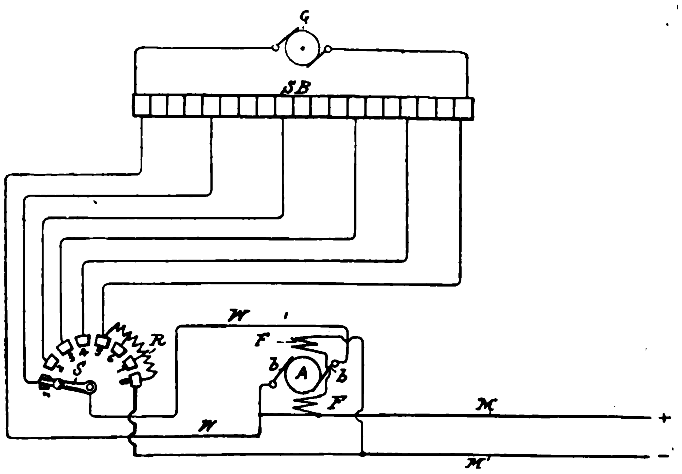


FIG. I.—STORAGE BATTERY AND MOTOR CONNECTIONS.

With printing press work, the operations of making up and threading in paper require a positive fixed speed of from 12 to 20 r. p. m. on the main shaft of the press. The common methods of obtaining this speed from electric motors are to employ either fixed resistances, two armatures in multiple and series, or separate sources of supply, such as motor-generators. The motor in the last case is a shunt machine, wound for the line voltage, while the generator is a shunt machine with field separately excited from the line at constant voltage, of course. The armature is wound to give a fixed e. m. f. of from 12 to 40 volts, depending upon the special requirements.

It is in connection with this last system that the method mentioned in this paper is particularly applicable. Fig. 1 shows the connections to the storage battery and to the motor through the controller. The following data have been obtained in connection with the utilization of this system for the operation of quadruple Hoe printing presses of moderate size. These presses operate at 12 r. p. m. in making up and threading in, and require for this purpose a current of 150 amperes at 40 volts. The threading in and making up process for each press lasts at most not more than ten minutes. This process has to be repeated not more than fifteen times in twenty-four hours. From these data it is apparent that a 200-ampere-hour battery on an hour rating will more than fulfill the requirements.

A battery of accumulators to give 40 volts and 200 amperes for one hour will cost not more than $400, which is not a prohibitive figure, especially when considered in connection with the following additional advantages:

(*a*).—One battery will serve a number of press motors, for the reason that all of the presses in any establishment are not simultaneously in operation.

(*b*).—The battery can be on charge at a very low rate at all times when current is flowing on the mains, thus insuring the best possible results from the battery at a minimum cost for current.

(*c*).—The battery having no moving parts, such as bearings and commutators, to get out of order, will appeal to the press operators.

(*d*).—The e. m. f. of a battery is constant, while that of any other independent source of supply is variable, depending upon the line voltage. Many a press operator has lost several fingers because of sudden variations of voltage supplied to the motor.

The operation of elevator motors by means of a storage battery placed directly across the line, and in connection with a multiple series controller, offers an excellent means of varying speed. The battery can be figured on a two-hour rate in the severest service, so that the first cost is not excessive, while the saving from repairs to resistance plates and contact pieces is a matter of no small importance in comparing the economic advantages of two systems.

The use of a battery for the multiple voltage operation of machine tools, presents another phase of the subject. The high first cost of batteries militates against their adoption. In a shop requiring about 100 kilowatts average motor load, the battery capacity will have to be calculated on a three-hour rating. The first cost will be about 30 per cent. more than that of equivalent multiple-voltage generators as now employed. That the battery is 30 per cent. more expensive in first cost does not, however, exclude it from competitive consideration, because of the increased efficiency of the cells over that of multiple-voltage generators when operating at varying loads.

As a substitute for storage batteries one can often use so-called counter-electromotive-force cells. These may be constructed with unformed lead electrodes in an ordinary battery electrolyte. The necessary electrode surface is not determined by the ampere-hour capacity of the plates, but by the internal resistance requirements for economic operation. The cost of construction of these cells is much less than that of equivalent batteries. The cutting down of the supply voltage by counter electromotive force is the natural method dictated by economic consideration, while to cut it down by resistance is unnatural.

Referring to the above paragraph, it is probable that careful examination will prove that the latter method of multiple voltage control, taken in connection with the weakening of the field to give the last 25 per cent. speed variation, will result in the most economical system to install and the lowest first cost for operation.

[The foregoing is a paper read before the American Institute of Electrical Engineers, November 21, 1902.]

Lessons in Practical Electricity

THE SERIES MOTOR.

Series-wound motors are used only for special classes of service, which are practically limited to railways, cranes and hoists. As the armature current passes through the field windings, a series-wound motor is capable of enormous starting torque, because (for a given armature winding) the torque is proportional directly to the product of the field strength and the armature current, and the field strength and armature current of a series-wound motor increase together (but not at the same rate). This feature makes the series-wound machine preferable for any work where a motor must start up under full load or overload, is operated intermittently, and need not run at any constant speed.

The running speed of a series motor without auxiliary regulating appliances depends entirely on the load, assuming a constant-potential supply circuit. As in the case of the shunt-wound machine, its speed is determined primarily by the field strength, the e. m. f. at the brush holders and the drop in the armature and brushes. The speed must be such that the counter e. m. f. generated in the armature is equal to the difference between the brush e. m. f. and the internal drop; thus, $e = E - v$, the counter e. m. f. being represented by e, the impressed e. m. f. (at the brushes) by E, and the armature drop by v. And as the counter e. m. f. e is proportional to the field strength, and the latter varies roughly with the current, variations of the latter will cause opposite variations in the speed—an increase of current will cause a decrease in speed (due to the increase in field strength), and *vice versa*. This speed variation is greatly enlarged by reason of the field winding being in series with the armature.

Thus, suppose a series-wound motor which has been driving a certain load be given additional load of say 25 per cent.; the torque will then be insufficient for the new load, and the armature speed will begin to drop, thus reducing the counter e. m. f. and allowing more current to flow, until the current and field strength have increased sufficiently to give the required increase in torque. For simplicity suppose that an increase of 15 per cent. in current would cause an increase of 8.7 per cent. in field strength; then the torque would be increased 25 per cent. Again, suppose the drop in the armature and field magnet to have been 10 per cent. before the change in load; with an increase of 15 per cent. in current the drop will be increased to 11½ per cent., reducing the required counter e. m. f. to 98.3 per cent. of the former counter e. m. f. But as the field strength has been increased 8.7 per cent., the speed necessary to generate 98.3 per cent. of the original counter e. m. f. will be a trifle less than 90½ per cent. of the original speed. Thus a variation of 25 per cent. in load will have caused a speed variation of nearly 10 per cent. (The student should not infer that these are commercial figures; they are taken hap-hazard merely for the purpose of illustration and may or may not accord with some actual case.)

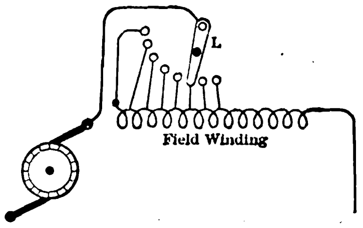


FIG. 1.—SECTIONAL FIELD WINDING.

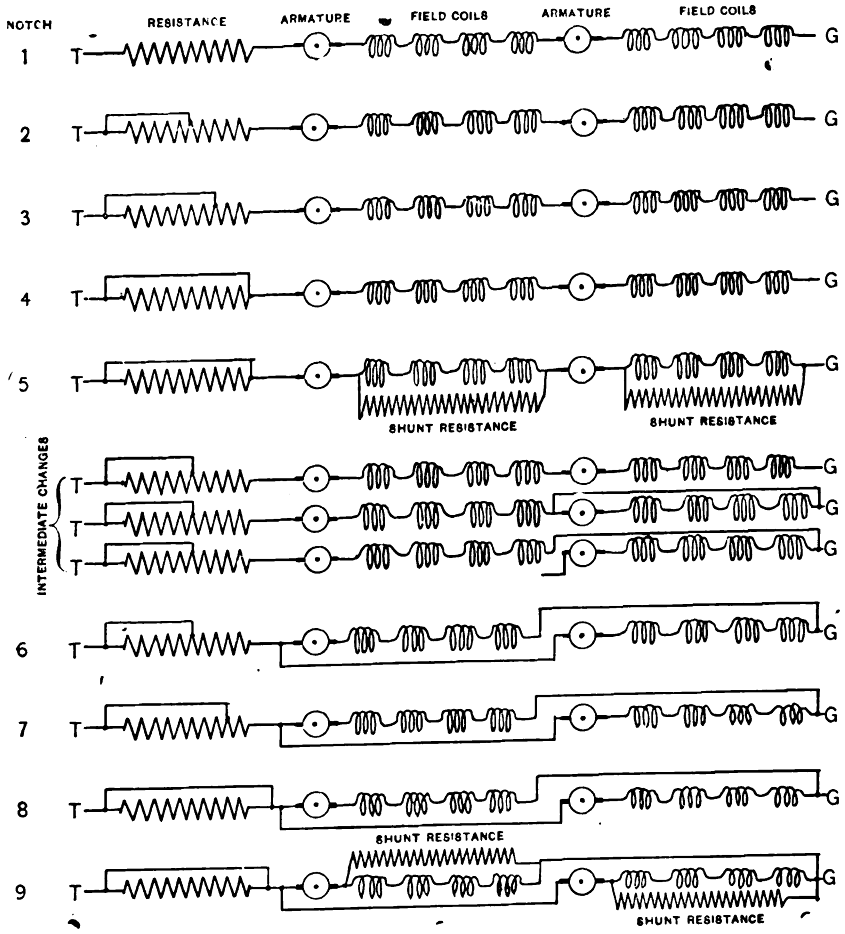


FIG. 3.—DIAGRAM OF THE SERIES-PARALLEL METHOD OF CONTROL.

The regulation of such motors is very frequently accomplished by cutting in and out sections of the field winding by means of an apparatus appropriately termed a "controller"; but in some instances speed variation is obtained by varying a resistance connected in parallel with the field winding, thus shunting more or less of the current away from the winding and correspondingly changing the field strength. Fig. 1 illustrates diagrammatically the first method and Fig. 2 the second. The former is greatly preferable to the latter so far as the excellence of the motor's operation is concerned, but the latter is much simpler in its application to the motor and gives smoother operation at the contacts of the controller. Both methods are used on motors driving hoisting apparatus.

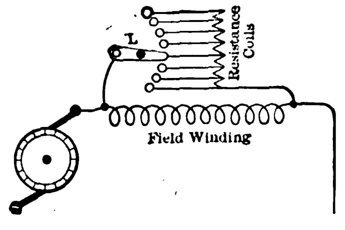


FIG. 2.—SHUNTED FIELD.

Motors driving railway cars are almost universally controlled by a combination method known as the "series-parallel" control, which consists of connecting two or more motors in series or in parallel and shunting the field winding with a resistance according to speed requirements. Fig. 3 shows the different connections made by the controller usually provided on ordinary surface-railway cars. Two motors are used on a car, and the controller has nine positions, which are commonly termed "notches" because a notched wheel and pawl are employed to insure the handle being brought to rest accurately, instead of being stopped between some two of the proper positions. In the diagram, the numbers down the left-hand margin, under the word "Notch," indicate the notches or positions of the controller handle, and the connections effected at each position are shown alongside the number of that position.

At the first notch the motors are connected in series with each other and with a resistance coil; the next step short-circuits part of the resistance coil, allowing more current to flow and increasing the impressed e. m. f. at the motor terminals; the motors thereupon speed up until the current is reduced to a value just sufficient to give (in conjunction with the also reduced field strength) the torque required to overcome the load. At the third position, more of the resistance is cut out, and all of it is out at the fourth position. No further increase in speed is possible with the motors in series, except by cutting out some of the field windings or shunting them; the latter operation is performed at the fifth position.

It is necessary now in order to get a still further speed increase, to put the motors in parallel, so as to raise the e. m. f. impressed at the terminals of each armature. But in order to avoid doubling the impressed e. m. f. at one step, and thus causing a sudden burst of high speed, the controller contacts are arranged to put back part of the resistance in series with the motors and to remove the shunt resistances around the field windings (thus strengthening the field) before putting the machines in parallel. These changes are indicated in the diagram as "intermediate changes," occurring as they do while the controller is moving from the fifth to the sixth notch. The progression beyond the sixth notch consists of the same successive steps that occur between the second and fifth positions.

The letters *T* and *G* in the diagram indicate "trolley" and "ground," one terminal of the car wiring system being carried to a "trolley" and the other "grounded" on the framework of the car truck. The trolley establishes a moving connection with a conductor which is located parallel with the track rails and is connected ultimately to one terminal of the dynamos which supply the operating current. The track rails are connected to the other terminal of the dynamos, and together the wheels and truck frame of the car constitute the other line conductor for the motors.

ring as they do while the controller is
"trolley" and the other "grounded" on the

[In last month's Lesson, an engraver's error caused wrong connections to be shown by Fig. 6. The free terminal of the small retaining magnet should have been shown connected to the *third* button of the rheostat instead of the second button. If the connection were made as the engraving showed it, the shunt field circuit would be opened when the lever reached the third button, and upon reaching the last button, the series field being cut out there, the field magnet would have no excitation.—EDITOR.]

Letters on Practical Subjects

Mr. Diffey's Telephone Problem.

To the Editor, American Electrician:—

Enclosed find two diagrams, each giving a solution to Mr. Diffey's problem in the November number. In Fig. 1 I use a double pole, 4-point strap switch and a 2-point strap switch, *S*. With the 4-point switch in position, *1*, (and *S* open) each line is connected through its bell to the ground; in position *2*, with *S* closed, the lines are connected together, through the desk set, and one bell to the ground; in position *3*, with *S* open, the east line is connected to the desk set and the west line to the booth; in position *4*, with *S* open, the east line is connected to the booth and the west line to the desk set. The switch *S* is used only to put the two lines together.

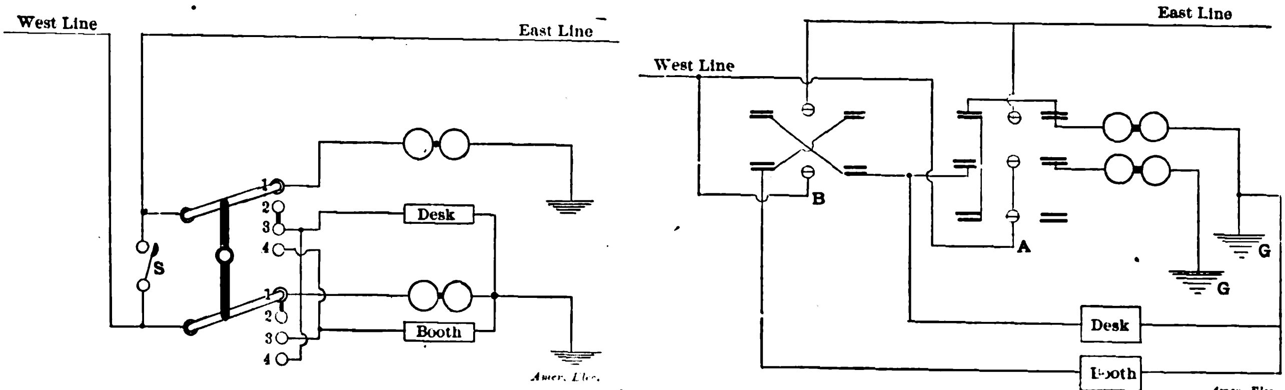


FIG. 1.—MR. POOL'S SOLUTIONS—FIG. 2.

In Fig. 2 I use a 3-pole double-throw switch and a 2-pole double-throw switch. Throwing *A* to the right connects each line through its bell to the ground; throwing it to the left connects the lines together, through the desk set and one bell to the ground; throwing *B* to the right connects the east line to the booth and the west line to the desk set; to the left connects the east line to the desk set and the west line to the booth. When one switch is closed the other is supposed to be open. However, if *A* is closed to the right, the only difference when *B* is closed is that the bells are connected in. When *A* is thrown to the left, of course that puts both the office set and the booth on the two lines together, whether *B* is thrown to the right of left.

New York City. C. H. Pool.

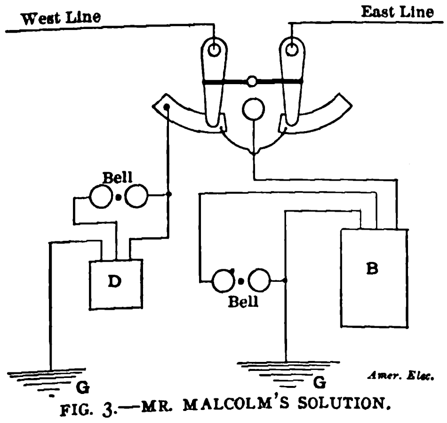


FIG. 3.—MR. MALCOLM'S SOLUTION.

To the Editor, American Electrician:—

The accompanying diagram, Fig. 3, is offered as a simple solution of the problem in telephone connections submitted by Mr. John A. Diffey last month. Referring to the diagram, the desk set is indicated by *D*, and the booth set by *B*. One of the bells is connected permanently to the desk set, and the other one is similarly connected by an extension line to the booth set. The desk set and booth set are permanently grounded. With the double-pole strap switch in the position shown in the diagram, the two lines are connected together and the desk set and bell are bridged across between them and the ground. If the switch is thrown to the left the west line remains connected through the desk set to the ground, and the east line is transferred to the booth set. If the switch is thrown to the right, the desk set remains in circuit with the east line while the west line is connected to the booth set. It is scarcely necessary to say that the bridging bells are thrown out of circuit by the hook switches of the desk set and booth set during conversation.

Brooklyn, N. Y. Geo. W. Malcolm.

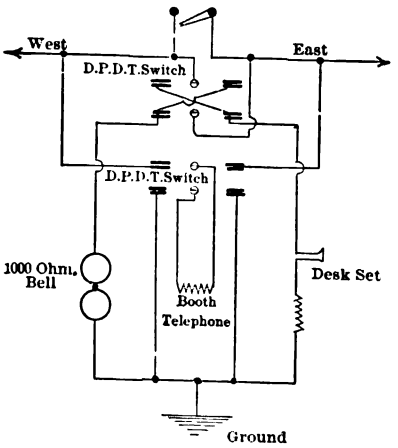


FIG. 4.—MR. TEMPLE'S SOLUTION.

To the Editor, American Electrician:—

I submit herewith a diagram (Fig. 4) which I think will cover the circuit problem of Mr. Diffey appearing in your November issue. The desired results are attained by the use of two double-pole, double-throw switches and one single-pole, single-throw switch. I have assumed from the wording of the problem that the desk set is provided with a 1,000-ohm bell, and the diagram is drawn with this in view. I hope that this may prove of use to Mr. Diffey.

Los Angeles, Cal. C. H. Temple.

To the Editor, American Electrician:—

I enclose a diagram of telephone switch connections to meet the requirements of Mr. Diffey, published in the November number of the American Electrician. It will be seen by reference to the diagram (Fig. 5) that the result is accomplished by using three single-pole double-throw, and one single-pole, single-throw, knife switches. The switch *A* is normally kept on the right-hand point, in which position both lines are grounded through their respective bells. When the switch is on the left-hand point, the lines are connected together, and the east line's ground circuit through its bell is opened. Switch *B* is normally left off both points, and is thrown to right or left, as it may be desired, to connect the booth telephone to the east line or the west line, respectively. Switch *C* is also normally left off both points, and is thrown to the right or left to connect the desk set with the east line or the west line, respectively.

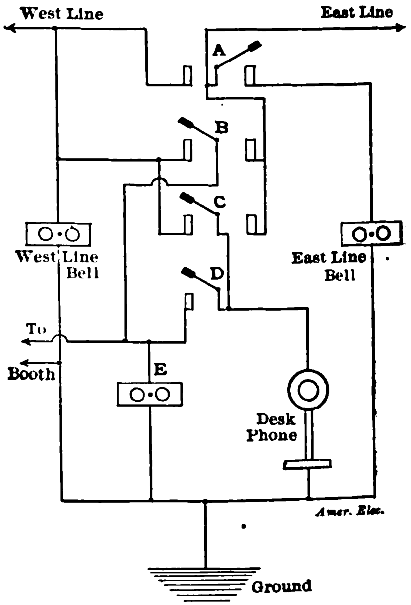


FIG. 5.—MR. PATTEE'S SOLUTION.

Although not specified in Mr. Diffey's letter, I have added switch *D*, which doubtless will be useful in establishing connection between the booth telephone and the desk set, without making use of either the east or the west line wires. The bell *E* is used to signal from the booth telephone to to the desk set. If desired, a switch could be inserted in series with this bell, to cut it out when the booth telephone is being used; this, however, would not probably be needed.

ALLAN W. PATTEE.

Monmouth, Ill.

To the Editor, American Electrician:—

In answer to Mr. John A. Diffey's problem, I submit the accompany solution (Fig. 6). Four double-throw telephone switches are needed. They must have normal and outside contacts. By arranging the switches as shown, any combination can be obtained. When No. 1 is thrown to the right or the left, the lines are connected through and one bell and ground cut-out. Throwing switch No. 2 to the right connects the booth to the east line and throwing it to the left connects it to the west line. Throwing No. 3 down puts the desk set on the east line, and throwing it up puts ringing current on the east line. No. 4 down gives the desk set to the west, and when thrown up puts the generator on the west line.

WM. A. LOVELAND.

Philadelphia, Pa.

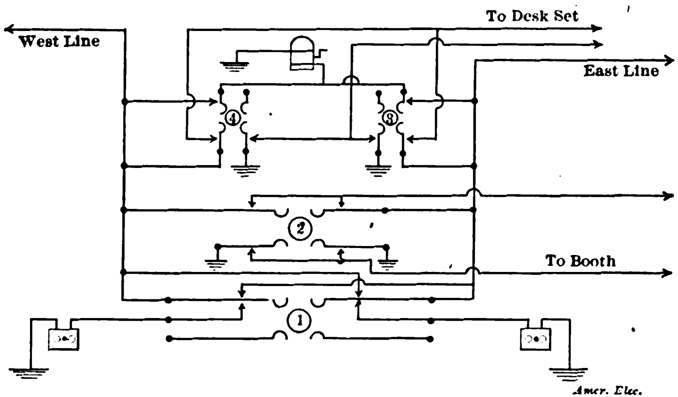


FIG. 6.—MR. LOVELAND'S SOLUTION.

To the Editor, American Electrician:

I wish to submit the enclosed diagram (Fig. 7) as a solution of Mr. John A. Diffey's telephone problem in the November issue. When the lower switch is thrown downward and the upper (two lever, three-point) switch is over toward the right, the desk set is in connection with the line going east and the public booth in connection with the line going west. When the levers of the upper switch, which move simultaneously, are thrown to the left, these connections are reversed. The extension bell is bridged across the instrument in the booth, consequently notifying the operator whenever that instrument is called. When the lower two-point, double-throw switch is thrown upward, the two lines are connected and grounded through the desk instrument, irrespective of the position of the upper switch. The desk set is assumed to include a 1,000-ohm bridging bell.

A. V. BRIGGS.

Danbury, Conn.

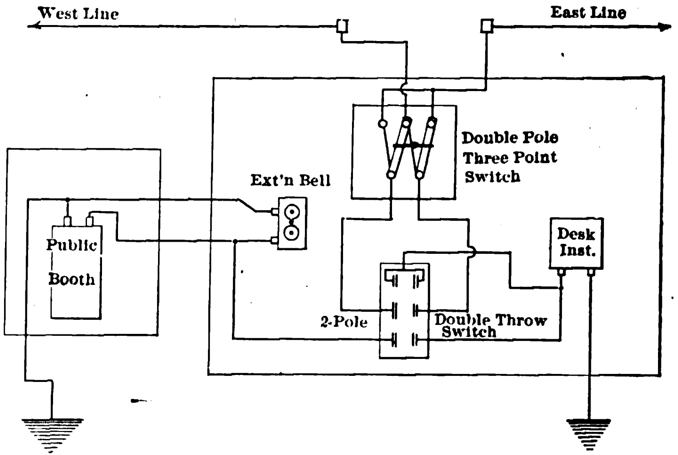


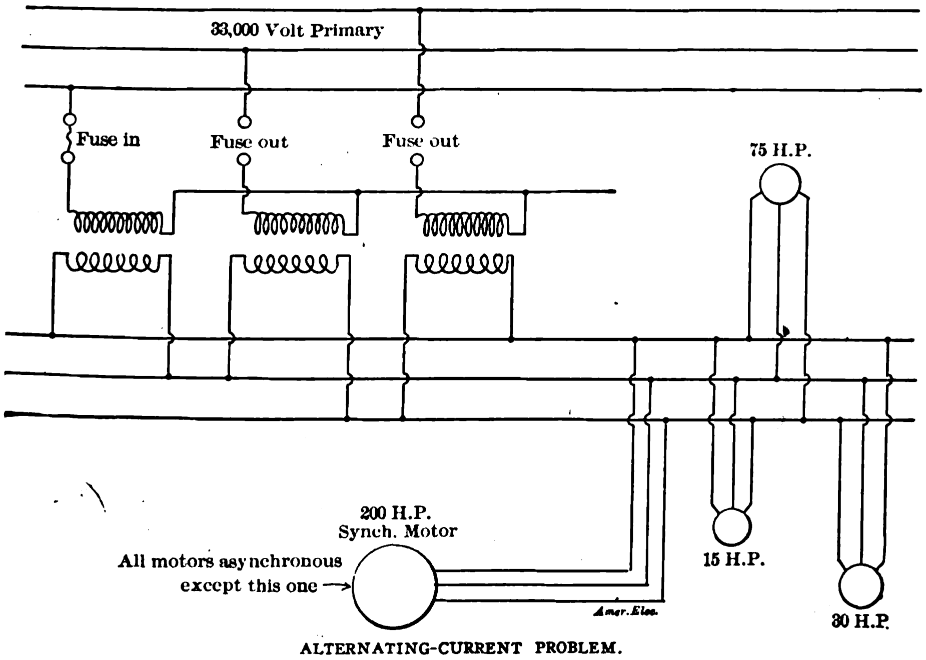
FIG. 7.—MR. BRIGGS' SOLUTION.

Alternating-Current Problem.

To the Editor, American Electrician:—

The electrical plant of a cement works is tapped directly from a three-phase main line operated at 33,000 volts, the cement works plant being operated Y to delta with the neutral of the Y grounded Fuses are provided on both the primary and secondary sides of the transformers. The cement works plant consists of a 200-h.p. synchronous motor and a number of induction motors. The synchronous motor is brought up to speed by an engine and thrown in by induction, and it has happened several times that two of the three primary fuse switches were not closed when the synchronous motor was thrown in. The induction motors were afterwards put on and all went apparently as well as usual. At the generating station the ground ammeter showed 8 amperes. The question is, how did the synchronous motor keep in step, and where did the induction motors get their second and third phases from with which to produce a rotating field with two of the three primary fuses out? The circuit relations of the various machines are indicated by the accompanying sketch.

Craftonville, Cal. **F. P. BENJAMIN.**

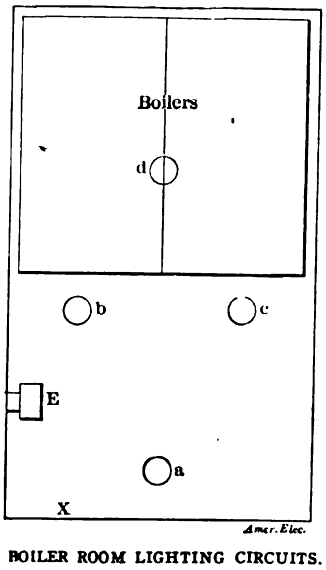


ALTERNATING-CURRENT PROBLEM.

Boiler Room Lighting Circuits.

To the Editor, American Electrician:—

As problems appear to be the order of the day, perhaps the following may be found of interest. The diagram herewith represents roughly the plan arrangement of a boiler room in which the circles *a*, *b*, *c* and *d* indicate 115-volt lamps. It is



BOILER ROOM LIGHTING CIRCUITS.

required that any two or all four of these lamps shall be lighted through a suitable arrangement of switches and wiring, from a 230-volt supply circuit, which, in the actual plant, entered on the left of the boiler room, as indicated at *E*. The point of entrance, of course, is not material, and is only shown because it conforms to the facts in the case. The wiring must be done so as to entail the most economical use of wire and switches, and must conform to the Underwriters' rules. The switches must all be located at the point indicated by the letter *X*.

T. H. Lohman.

Denver, Colo.

◆

Solutions of Mr. Chase's Problem in Telephone Circuits.

The enclosed diagram indicates one method of meeting the requirements stated in Mr. Chase's letter in the November number. Three jacks are installed at the main office, the factory line terminating at the jack *F*, the annex line at the jack *A* and the secondary office line at the jack *S*, a common wire, *C*, being used for one side of both of the latter lines. The main office instrument is connected to an ordinary jack plug by means of which it can be put in connection with the general factory circuit or either one of the annex stations. The factory circuit is also provided with a plug by means of which it can be put in connection with either one of the annex stations.

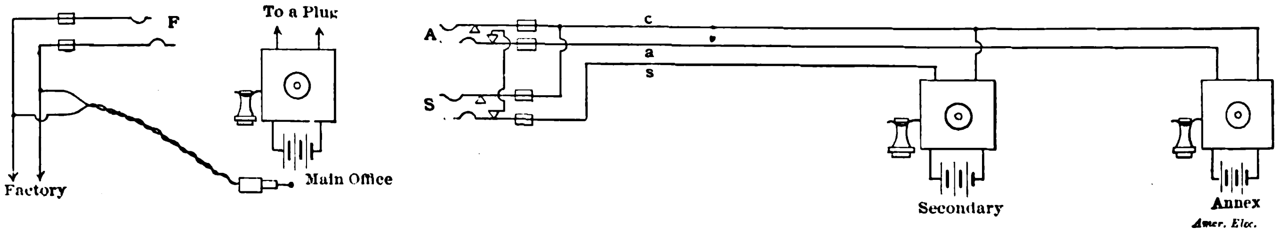


FIG. 1.—MR. MALCOLM'S SOLUTION.

As it is not desired to have the secondary office or the annex call up the main office, the instrument at the main office would normally be plugged in on the general factory circuit. Should any of the factory stations desire to communicate with either one of the annex stations, the main office would have to be called up and the factory circuit plugged into the jack *A* or *S* as might be desired. It is obvious that the two stations in the annex are connected normally in parallel by their jack springs, so that they can communicate with each other except when the main office instrument or the factory circuit is in communication with one of them. The main office instrument would be of the same type as the instruments in the secondary office and annex; this would not make the use of this instrument objectionable on the general factory circuit.

Brooklyn, N. Y. Geo. W. Malcolm.

To the Editor, American Electrician:—

Referring to Mr. Chase's problem in telephone connections which appeared in the November number of the American Electrician, I beg to submit the accompanying sketch (Fig. 2) as a solution. A common wire is run from the main office instrument to both the secondary office and the annex, and individual wires are run from a 6-point switch in the main office to these two stations. With the switch in the position shown in the sketch, the main office instrument is connected to the secondary office. With the switch on the buttons *a* and *a*, the main office is connected to the annex station, and with the switch on the buttons *n* and *n*, the main office is disconnected from the two auxiliary stations and those two are connected together; this is the normal position of the switch. The main office instrument can then be plugged into the general factory circuit. Should it be desired to establish communication between the general factory circuit and either one of the annex stations, the main office instrument would be left plugged into the factory circuit and the 6-point switch turned to the proper position.

Geo. A. Burnham.

Winchendon, Mass.

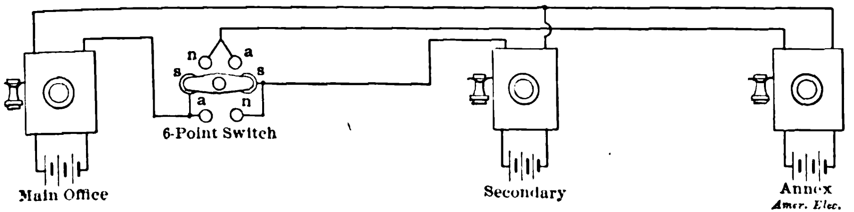


FIG. 2.— MR. BURNHAM'S SOLUTION.

To the Editor, American Electrician:—

If I correctly understand Mr. Chase's letter in the November number of your paper, I thing the accompanying diagram (Fig. 3) fulfils the requirements of his problem. The secondary office and the annex station are permanently bridged together, and their line terminates at a jack *A* in the main office. The factory circuit is carried to the jack *F*. The main office instrument terminals are carried to an ordinary plug by means of which this instrument can be put on either the general factory circuit or the annex circuit. Provision whereby the main office may call up either the secondary office or the annex selectively is readily made by using a single ring for one station and two rings for the other. An additional plug (not shown) can be attached to either the annex circuit, or the general factory circuit in order to establish connection between the two. The main office instrument would normally remain plugged into the factory circuit-jack, *F*.

James B. Dillon.

Louisville, Ky.

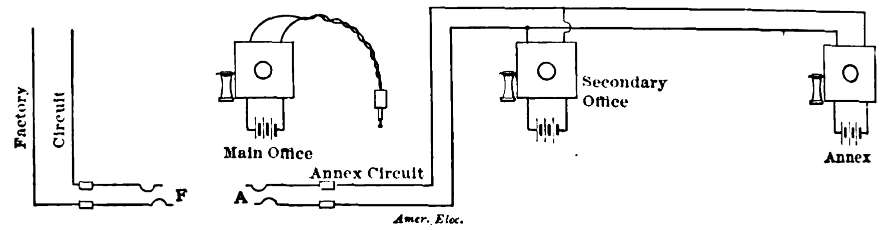


FIG. 3.—MR. DILLON'S SOLUTION.

To the Editor, American Electrician:—

The diagram sent herewith (Fig. 4) shows one method of giving the results required by Mr. Chase's problem in the November number. Two telephone switch keys, *A* and *B*, are here employed, one with normal contact, and the other with outside contact. The secondary office and the annex station are bridged permanently together, and the switches are normally in the position shown, leaving the main office instrument connected to the factory circuit. Throwing the switch *A* connects the factory circuit with the annex circuit *A*, with the main office instrument bridged across. Throwing both switches disconnects the main office instrument from the factory circuit and connects it to the annex circuit. The construction of the switches that is indicated in the diagram is purely conventional; any one familiar with telephone

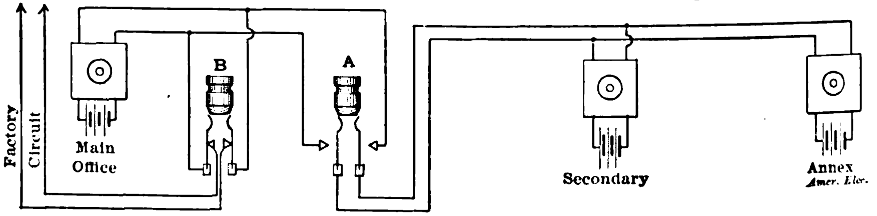


FIG. 4.—MR. LOVELAND'S SOLUTION.

switchboards will understand what the actual construction would be.

Philadelphia, Pa. Wm. A. Loveland.

Electrical Catechism

713. Why are hot solutions used in electrogilding work?

Electrogilding may be performed with either hot or cold solutions; but for most practical purposes hot solutions are used. When gold is deposited from cold solutions the color of the deposited metal is usually of a yellow color, and not of the rich orange-yellow tint which is the natural characteristic of fine gold. The gold, moreover, is more crystalline and consequently more porous, in cold than in hot solutions, and is, therefore, not so good a protective coating to the underlying metal. The gold deposited from hot solutions is not only of a superior color and of a closer texture, but it is also obtained with a much greater rapidity. In a few seconds of time an article may be gilded of the finest gold color, with scarcely an appreciable quantity of the precious metal, while in the course of a few minutes a coating of sufficient thickness may be obtained to resist a considerable amount of wear. The superior conductivity of hot solutions also enables the operator to gild many metallic surfaces such as tin, lead, Brittania metal and steel, which could not be plated satisfactorily with cold solutions. Another advantage of using hot gilding solutions is that they dissolve readily any trace of greasy matter, or film of oxide which may be present on the surface of the work through careless treament, and thus clean the surface of the work for the reception of the gold deposit.

714. How are gilding solutions made by the battery process?

The system of forming gold solutions by electrolysis has much to recommend it; the process requires but little manipulation, and in inexperienced hands is less liable to involve waste of gold than the ordinary chemical methods of preparing gilding solutions. A gold bath made by the battery process, moreover, if the cyanide be of good quality, is the purest form of solution obtainable. To prepare the solution dissolve about 1 lb. of good cyanide in 1 gallon of hot distilled water. When it is all dissolved, fill a perfectly clean and new porous cell almost full with the cyanide solution, and stand it upright in the vessel containing the bulk of the solution, taking care that the liquid in each vessel stands at the same height. Next attach a clean block of carbon or strip of clean copper to the negative pole of a voltaic battery, and immerse this in the porous cell. A gold anode attached to the positive pole is next placed in the bath, and the voltaic action kept up until about 1 oz. of gold has been dissolved in the solution, which is easily determined by weighing the gold before and after immersion. The solution should be maintained at a temperature of 130° to 150° Fahr., while it is under the action of the current.

Another method of preparing gold solutions by the battery process is to attach a large plate of gold to the positive, and a similar plate of gold or block of carbon to the negative electrode, both being immersed in the hot cyanide solution given in the preceding paragraph, and current from 2 Daniell cells passed through the liquid. The negative electrode should occasionally be replaced by a clean cathode of sheet German silver for a few moments, to ascertain whether the solution is rich enough in metal to yield a deposit. If the solution is in a condition to gild German silver promptly with an anode surface of about the same extent, the bath may be considered ready for use. The proposition of gold per gallon of solution may be greatly varied; from one-half ounce or even less to two ounces of gold being employed, but larger quantities of cyanide must be used in proportion. While the gold is dissolving in the solution the liquid should be occasionally stirred. In working the bath a temperature of from 130° to 150° Fahr. should be maintained, the lower temperature being preferable.

715. What precautions are necessary in making solutions by the battery process?

In making solutions by the battery process, the position of the anode should be shifted from time to time, otherwise it is liable to be eaten through at the part nearest the surface of the solution where the electrochemical action is greatest. A good way to prevent this is to punch a hole at each corner of the gold anode, and also a hole midway between each of the corner holes, through which the supporting hook may be successively passed; this arrangement will admit of eight shiftings of the anode. Another plan is to connect a stout platinum wire or a bundle of fine wires to the anode by means of gold solder, and to immerse the whole of the anode in the cyanide solution; this is a very good plan for dissolving the gold uniformly, since the platinum is not acted upon by the cyanide.

716. When are cold gilding baths used?

The cold gilding bath is sometimes used for very large objects to avoid the necessity of heating great volumes of liquid. As in the case of hot solutions, the proportions of gold and cyanide may be modified considerably. Any double cyanide of gold solution may be used cold, provided it be rich both in metal and its solvent, cyanide of potassium, and a sufficient surface of anode is immersed in the bath during the electrodeposition.

717. What precautions are necessary in plating with a cold gilding solution?

When a pure yellow color is desired, a newly prepared double cyanide of gold solution in which a moderate excess of cyanide is present, and containing from 1 to 2 ozs. of gold per gallon, will yield excellent results with the current from a single Daniell cell; but sufficient anode must be exposed in the solution to admit of the deposit taking place almost immediately after the article is immersed in the bath. The anode may then be partially raised out of the solution, and the deposition allowed to take place without further interference than an occasional shifting of the object to coat the spot where the slinging wire touches. After the article has been in the bath a minute or so, the operator may assure himself that deposition is progressing satisfactorily by dipping a piece of clean silvered copper wire in the bath, and allowing it to touch the object being plated; when if the end of the wire becomes coated with gold, he may rest assured that the deposition is proceeding favorably. Care must be taken, however, that the deposit is not too rapid, for it is absolutely necessary that the action should be gradual, otherwise the gold may strip off under the action of the scratch-brush. If any portions of the work appear patchy or spotted, the pieces must be removed from the bath, rinsed and well scratch-brushed.

It is not advisable to employ a current of high intensity in cold gilding; the Daniell cell is most suitable, and when a series of cells is required to gild large surfaces or a considerable number of objects, the batteries should be connected in parallel, that is, all the positive electrodes should be connected to the anodes and all the negative electrodes put in communication with the conducting-rod supporting the work in the bath. After deposition has taken place to some extent an extra cell may be connected, followed by another, if necessary, and so on; but while only a thin coating of gold is upon the work, the strength of the current should be kept low. Deposition takes place more slowly on gold than upon copper, or its alloys, therefore an increase of current becomes necessary after a certain thickness of gold has been deposited. If the current be too weak on the other hand, the deposit is apt to occur only at the prominent points of the article, and upon those portions nearest the anode. It sometimes happens with newly made baths that when the articles are shifted to expose fresh surfaces to the anode, the gold already deposited upon the work is dissolved. When such is the case, it generally indicates that there is too great an excess of cyanide in the solution, although the same result may occur if there be too little gold or the current too feeble. When the bath is not in good working order, the gold anode must be withdrawn from the solution, otherwise it will be dissolved by the cyanide. It is a remarkable phenomenon that solutions of cyanides, even without the action of electricity, rapidly dissolve in the cold all the metals except platinum, while at the boiling point the cyanides have scarcely any action upon these same metals.

Queries and Answers

IMPORTANT.—No attention will be given to inquiries which do not give the full name and address of the inquirer.

What is the best substitute for transil oil in transformers? R. G. C.

Boiled linseed oil.

Are the red lead and litharge used on storage battery plates the same that painters use? J. H. F.

Yes.

How many feet of 30 per cent. German silver wire, No. 14 gauge, will give a resistance of 20 ohms? J. H. G.

About 415 feet.

How do earth currents affect instruments such as a Wheatstone bridge when the circuit to which the instrument is connected is grounded? C. H. B.

Not at all.

What is the formula for the fusing point of copper wire safety fuses? J. B. M.

Representing the diameter of the wire in inch measurement by d, the following formula will give approximate results:

$$10{,}250 \times \sqrt{d^3} = \text{fusing current.}$$

How can the consumption of zinc and chemicals per hour in a battery be calculated? H. L. H.

By means of the formula

$$2.1 \times e \times t \times I = \textit{ounces.}$$

In this formula e is the electrochemical equivalent, t is the time in minutes, and I is the current in amperes.

Will a transformer built for a 60-cycle circuit operate satisfactorily on a 133-cycle circuit of the same voltage? (2) If so, should the primary winding be connected as usual, or should it be connected for one-half of the voltage? J. A. S.

Yes. (2) The connections should be the same as for 60 cycles.

How is the speed of a direct-current shunt-wound motor determined? M. C. H.

By the field strength, the number of wires on the armature core, and the e. m. f. applied to the brushes. Read the Lessons Department in the September, October and November issues.

How is the equalizer between the rectifiers of two polyphase alternators connected? J. H. D.

No equalizer connection is necessary. The division of load between alternators in parallel is determined by the power applied to the shafts of the machines if there is no speed governor; in the case of modern steam engines, the division of the load is determined by the governor adjustment.

Will the secondary of an induction coil give a greater current or e. m. f. with a 4-volt battery connected to its primary than the battery would give connected merely through a vibrator? P. H.

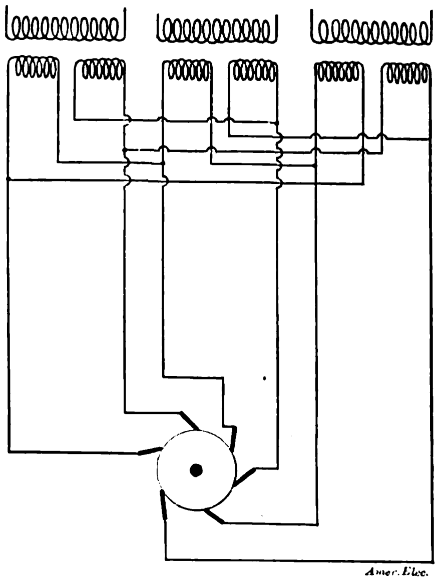
If the coil is of the ordinary kind in which the secondary winding has a much greater number of turns than the primary, the secondary e. m. f. will be immensely greater than the e. m. f. of the battery, and the volume of current will be correspondingly smaller. Connecting the battery to a vibrator has not the slightest effect upon its e. m. f.

Why does a change in the field strength of an alternator change the power factor of the circuit? A. C.

It does not; it only changes the power factor of the machine itself, so to speak, when it is operated in parallel with other alternators. The power factor of the circuit is affected by the power factor of the machine exactly in the same way that it is affected by the power factor of a motor supplied from the circuit.

Please publish a diagram showing how six phases can be obtained from three transformers supplied from a three-phase circuit. (2) What is the object in converting from three phases to six? A. C.

Six phases may be obtained from three transformers, as shown by the diagram herewith. The transformers must each have two secondary windings, as indicated in the sketch. This arrangement is used only in connection with rotary converters, and the reason for it is that it reduces the heat losses in a given armature and otherwise increases the efficiency of the winding, so that the ultimate output capacity of the machine is increased, as compared with the three-phase connection. A given converter armature will have about 50 per cent. more capacity with the six-phase connection than with the three-phase.



Should the field magnet of a rotary converter, operated in the ordinary manner, be excited from the direct-current brushes of the machine or from a small dynamo? (2) Is the ability of an alternator to withstand a short circuit at the terminals without damage a good or bad feature? W. W.

It depends on the conditions under which the machine is operated. If it must be started from the alternating-current side, it is preferable to have separate excitation; if it can be started always from the direct-current side, there is no need of an independent exciter. (2) Generally speaking, this ability would indicate an excessive amount of self-induction in the armature, which is objectionable in constant-potential machines for the reason that it impairs the regulation.

I have eight vibrating bells connected in parallel on different floors of a building and supplied with current from a battery of six sal ammoniac cells in series. The bells rang all right for a little while, but the battery will not ring all of them now. Should more battery be added, and, if so, should it be connected in series with the present battery or in parallel? T. P.

The present battery will probably ring the bells fairly well if connected in two parallel groups of three cells in series in each group, but it is extremely advisable to add six more cells. The twelve cells should be connected in parallel-series, putting three cells in each series group; if the distances are so great that satisfactory results are not obtained, change the grouping to four cells in series with only three groups in parallel instead of four.

What is the relation between the speed of an induction motor and the frequency of the supply circuit? (2) What is the difference in construction between a single-phase and a three-phase induction motor? (3) What is the difference in the efficiency of a small single-phase motor working on a single-phase circuit and working from two wires of a three-phase circuit? C. E. C.

The synchronous speed (the speed at which the motor would run if it were in absolute synchronism with the circuit) is equal to twice the frequency divided by the number of poles per phase; the actual speed is from 2 per cent. to 10 per cent. below this. The speed varies inversely with the load, exactly as in the case of a direct-current shunt-wound motor. (2) The single-phase machine has a single winding on the stator for regular operation, and usually has a second winding for starting, the latter winding being thrown out of circuit when the machine reaches normal speed. A three-phase motor has three windings on the stator, all of which remain constantly in circuit; no extra winding is necessary for starting. (3) There is no difference.

If two similar alternators are connected in parallel and the field excitation of one is reduced below that of the other, a cross current will flow between the machines which will lag in the armature of the stronger machine and lead in the armature of the weaker machine, the effect being to weaken the field of the stronger machine and strengthen that of the weaker machine until the two are approximately equal; the resultant e.m.f. of the system will be lowered. Now, if, instead of reducing the field excitation of one machine, that of the other one is strengthened, the same character of cross current will be produced with the same results, but the resultant e.m.f. of the system will be raised. Why are the cross currents the same in both cases while the effects on the resultant e.m.f. of the system are opposite? W. J. S.

The character of the cross currents is the same because the relation between the field strengths is the same. If the two machines are running exactly alike at, say, 1000 volts, and the field strength of one is reduced so that if operated alone it would give 980 volts, it is evident that the resultant e.m.f. must be less than 1000 volts, because, as stated above, the field of the normal machine is weakened by the lagging current in its armature so that it no longer gives 1000 volts. The resultant e.m.f. will be somewhere between 980 and 1000. If, on the contrary, the field strength of one machine were increased so that its e.m.f. if running alone would be 1020 volts, the resultant e.m.f. of the system would be raised because the field of the normal machine would be strengthened by the leading current in its armature.

ELECTRICAL TESTING LABORATORY.

Large corporations throughout the country have for years maintained laboratories and skilled experts for the purpose of testing their materials, supplies and apparatus. Unfortunately, the cost of the equipment and the expense necessary to maintain such a laboratory in good working condition, together with the skilled attendance necessary, have debarred small manufacturers and buyers from maintaining so valuable a commodity in connection with their plants.

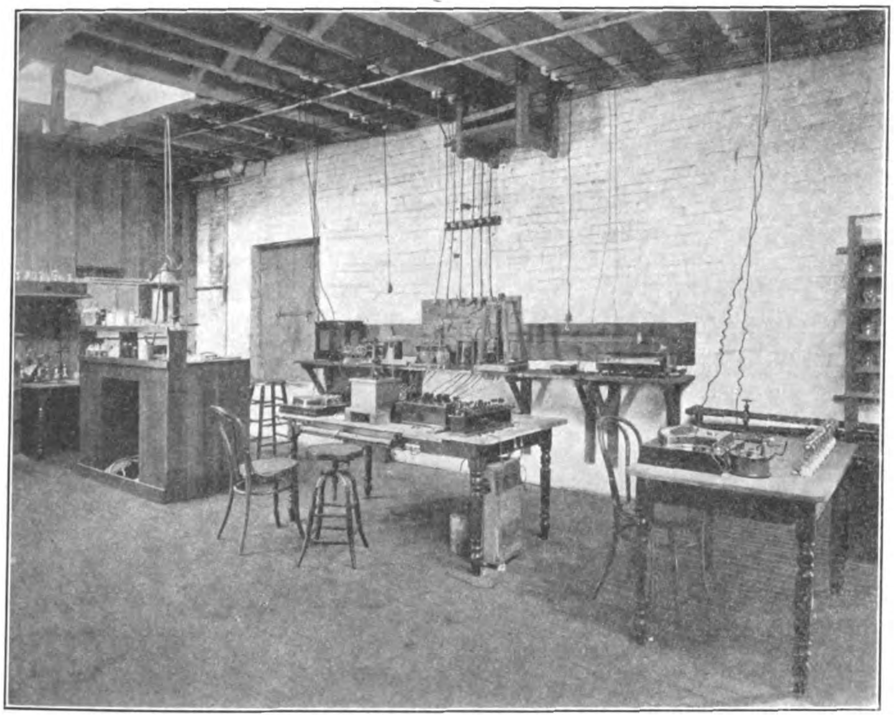


FIG. I.—CORNER OF ELECTRICAL TESTING LABORATORY.

To give this latter class all the advantages of a testing laboratory and skilled attendance, is the object of the recently incorporated Lamp Testing Bureau of New York City. Up to a short time ago, the Bureau operated as a department of the Association of Edison Illuminating Companies; but it now possesses a general electrical and photometrical testing laboratory, and is prepared to test all kinds of electric lamps, meters, instruments and apparatus, and to provide accurately calibrated incandescent lamps as secondary standards of candle-power, amperes, and watts, and Clark cells for use as standards of e. m. f.

The laboratories of the company are on the three top floors of the building at No. 14 Jay Street. On the 8th floor are the offices, and also a general electrical laboratory equipped with the requisite portable instruments as well as instruments and apparatus of precision. Among these are an accurately-adjusted Wheatstone bridge of the Anthony pattern, wound with manganin wire; a Thomson double bridge by Wolff, of Berlin, for the measurement of low resistances and of the conductivity of specimens of wire; potentiometers by Leeds & Co., of Philadelphia, and by Wolff, with a complete outfit of standard cells and with the requisite chemicals and apparatus for the preparation of standard cells; a complete set of manganin resistances by Wolff, running from 0.0001 ohm to 100,000 ohms, which are used as standards of resistance, and, in connection with the potentiometer, for the accurate measurement of direct currents up to 2,000 amperes; the platinum dishes and sensitive balance required to make standardizations by the silver voltameter. For alternating-current measurements, besides a very complete set of portable and semi-portable voltmeters, ammeters and wattmeters, there is a Rowland electro-dynamometer, with shunt box, by which a great variety of alternating-current work can be done, including much of what is entirely outside of the range of the ordinary instruments. There are also standard condensers, keys and secohmmeters for cable testing, determining coefficients of induction, capacity, etc. Alternating-current instruments are checked or standardized by reference to standardized direct-current instruments, using reactanceless transfer instruments. A standard photometer, equipped for making all kinds of photometric measurements, is also on this floor. The accessory apparatus for correcting measurements made with the Hefner amyl acetate lamp and the 10-c.p. pentane lamp, taking account of atmospheric conditions, is also on this floor. Fig. 1 shows a corner of the electrical laboratory.

On the seventh floor is a small converter driven by current from a storage battery, which furnishes alternating current for making instrument checks. There are also vibration-free meter boards with the necessary arrangement for making accurate tests, and complete laboratory investigations on recording electric supply meters, current being taken from storage batteries. In one end of the room is a battery of 300 storage cells used for testing purposes. Space is also provided on this floor for testing heavy apparatus.

On the sixth floor are the motor-dynamo, which supplies current to lamps on life test, working photometers for life-test measurements, and the racks on which lamps on life-test are set up to burn. These racks are at present capable of holding and supplying 1,100 incandescent lamps. The various pressures required are supplied to these lamps from a special sectional transformer, the e. m. f. of which is controlled by an attendant constantly on duty. Any integral voltage can be steadily maintained between 100 and 150 volts. The finer adjustments of voltage on individual lamps are made by placing suitable resistances in series with them. There is also being installed an integrating photometer for arc lamps similar to that devised by Prof. C. P. Matthews.

◆◆◆

THE AUTOMOTONEER.

The tendency in modern design is to make all apparatus and methods of operation as nearly "food proof" as possible. So much has been either damaged or destroyed, owing to the incompetency of operators, that it has been found expedient to surround apparatus, especially electrical appliances, with all possible safeguards.

Almost everything about an electric car is now food proof, excepting perhaps the controller movement; but we illustrate herewith a device which renders this immune from injury by preventing motormen from abusing and reducing the efficiency of the equipment of an electric railway. This device, which is known as the automotoneer, is mechanical in its action, and is placed in each controller for limiting to a predetermined time-limit the rate at which the controller can be advanced from one point to another. In principle, the automotoneer is very simple. The movement of the control handle to consecutive points on the controller raises a piston which drives air out of an air dash-pot. The raised position of the dash-pot locks the controller handle against further advance, until sufficient time has elapsed for the piston to resume its normal position by the flow of air into the dash-pot. The rate at which this air flows can, of course, be regulated by the adjustment of the size of the inlet, and this adjustment determines the time that must be taken between points on the controller.

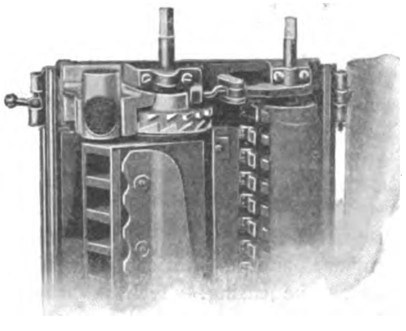


FIG. I.

Fig. 1 shows the automotoneer as it appears when installed in a controller, and Fig. 2 illustrates the parts more in detail. Fig. 3 shows the dash-pot and pawl independent of the wheel. This wheel, which is shown in Fig. 2, is put on the controller shaft in place of the usual notched plate. It has a zigzag groove cut in its periphery; the points in the groove corresponding with the points on the controller. It is plain that a pawl entering this groove will be raised from the time the controller is advanced one point. The pawl can be seen projecting from the small cylinder in Fig. 3. It is mounted on a lever, one end of which is pivoted at the back of the controller, as shown, and the other end of which is attached to a dash-pot piston. Movement of the controller handle forward, therefore, to turn on current raises the dash-pot piston, driving the air out of the dash-pot through an automatic release check valve. Once the dash-pot piston is raised, air begins to flow into the dash-pot through an adjustable opening allowing the piston to fall back to its original position in a time depending on the amount of opening allowed for the air to flow through. As soon as the dash-pot piston falls back to its first position, the pawl, which is on the same lever, falls so that it does not engage a tooth in the zigzag groove and the controller can be advanced. The pawl is constructed on the well-known principle of a door catch with one edge beveled off, thereby permitting the controller wheel to be revolved, so as to shut off current without engaging any of the teeth. It works in a cylinder, as shown, and is caused to enter the groove by an oiled spring which allows it to retract when the controller is thrown off, so that the point of the pawl does not come into engagement. The dash-pot piston has a long bearing surface and is lubricated with dry graphite. The casing, which is provided to cover the moving parts and prevent tampering by motormen, is shown in Fig. 1.

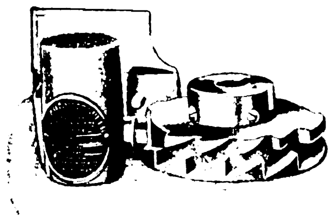


FIG. 2.

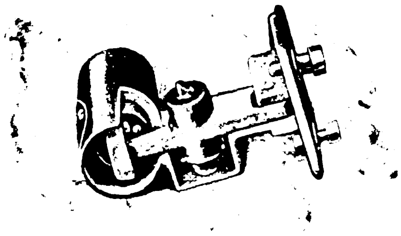


FIG. 3.

The automotoneer does not restrict the rate of acceleration, but limits the rate of turning on current, so as to secure the smoothest and the most efficient and rapid acceleration that may be desirable in each particular kind of service. Where cars operate over grades rendering it desirable to reverse and throw motors in multiple quickly in order to make an emergency stop when the brake fails and the current-supply is cut off when going down inclines, the automotoneer is provided with a magnetic release which throws it out of action when there is no current supplied. This device is manufactured by the Garton-Daniels Company, of Keokuk, Ia.

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NON-INDUCTIVE STARTING RHEOSTATS.

One of the great objections to the installation of alternating-current motors on general service circuits has been the abnormal starting current and the low power factor of this starting current. This objection has existed with both the polyphase and single-phase motors. The builders of both forms of motors have sought to minimize the difficulty by the use of auto-transformers in starting, thus reducing the voltage applied to the motor, and in consequence thereof the starting current.

The Wagner Electric Manufacturing Company have just announced in connection with its single-phase motors the introduction of a line of non-inductive starting rheostats, the use of which not only eliminates the objectionable starting current, but also performs the very desirable function of running the power factor of the starting current to a very high point. The accompanying diagram illustrates the effectiveness of the use of such a starting device, the curves referring to a 7½-h. p. motor operating at 208 volts and 60 cycles. It will be observed that the starting current at no time exceeds the running current by more than 25 per cent for full-load starting torque. The power factor of the starting current also is never less than the power factor of the running current, and throughout a great part of the starting range it is very much higher than the running power factor.

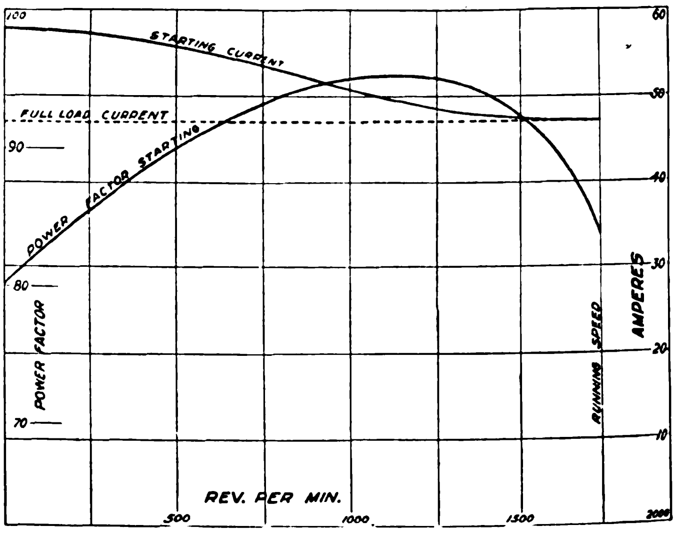

FIG. I.—CURVES OF STARTING CURRENT AND POWER FACTOR.

The starting rheostats by which this improvement is accomplished are ordinary non-inductive boxes, corresponding in practically every respect to the starting boxes for direct-current motors. They are practically supplied without the automatic spring release, the object of this omission, as compared with the direct-current starting boxes, being to avoid the shutting down of the motor in case of circuit switching at the central station. The motors of the Wagner Company may be started with or without these boxes, the ability to do so arising from the fact that the motors are entirely automatic in every respect.

In the smaller sizes, the majority of central stations prefer to install single-phase motors of the Wagner Company's type, without auxiliary starting devices of any kind. It will prove of advantage, however, with the larger motors, to use the rheostats; and as their use does not entail any large additional cost, it is likely that the installation of such motors with rheostats of larger sizes will find very general application. These rheostats are connected in the supply circuit, between the main switch and the motor.

◆

STANDARD SMALL MOTOR PANELS.

In large installations of electric power distribution there are many cases where small motors are located in places where it is essential that the motor starting apparatus shall occupy but little space and at the same time contain every device and qualification required by Underwriters' rules. With a view to supplying apparatus to fulfill these requirements, the Ft. Wayne Electric Works has prepared a line of small motor-control panels, one of which is illustrated herewith. These panels have been standardized for motors of ¼ to 30 horse-power, for 115, 230 and 500-volt circuits. They fulfill every requirement of the Board of Underwriters, and in addition possess several valuable features not specified in the Underwriters' rules.

The panels are made of 1½-in. slate free from flaws or metallic veins. They are enameled and baked several times to thoroughly remove moisture and prevent absorption, and are finally buffed and polished to a high finish. Each panel is complete in itself and includes in its equipment a "Wood" automatic overload and underload-release starting rheostat, a combined circuit-breaker and switch, an ammeter, a pilot lamp and two enclosed line fuses.

The rheostat is mounted on the back of the panel with terminals connected through the board to the contacts on the front. It is entirely fireproof throughout its construction. The conductor consists of wire coils mounted on porcelain insulators in an iron frame. The frame is covered or lined with asbestos insulation so that liability of short circuits or injurious arcing is reduced to a minimum.

Fig. 1 shows the panel as it appears when the motor controlled by it is running. The release at overload or no voltage is actuated by a double-wound solenoid having a double pivoted armature provided with a locking latch which engages the rheostat arm at running position. One of the solenoid coils is in series with the motor armature, and the other with the shunt field winding, but both produce the same polarity in the magnet.

An interruption of the supply of current permits the lower end of the solenoid armature to recede from the solenoid under the force of a spring on the lever arm, thereby releasing the rheostat arm which is thrown to the left to the "off" position by a spiral spring. The force with which the rheostat arrives at the "off" position trips the circuit-breaker attachment on the double-pole switch, throwing it open and entirely disconnecting the rheostat and motor from the circuit. The no-voltage release is designed with a time element sufficient to permit changing the power circuit from one generator to another, as is sometimes necessary, without interruption to the motor service.

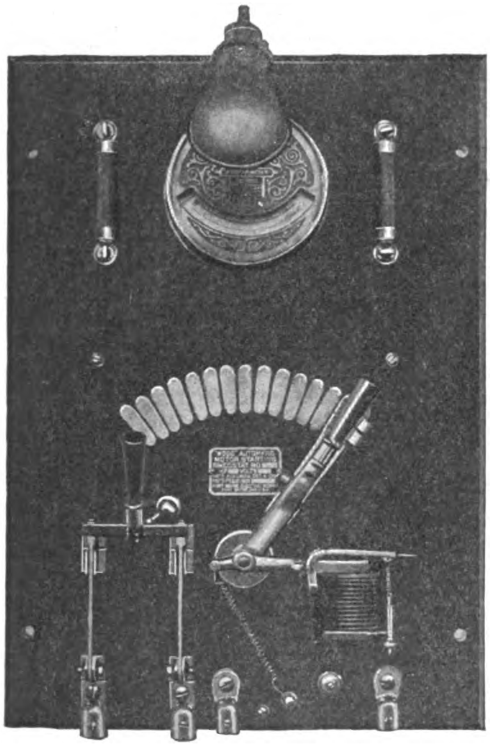

FIG. 1.—PANEL WITH RHEOSTAT IN RUNNING POSITION.

A sudden overload or a break in the motor field circuit will cause a heavy current to pass through the series winding on the solenoid, resulting in the attraction of the top of the armature, the release of the rheostat arm and the opening of the circuit in the same manner as above described for a no-voltage release. The release may be adjusted by means of a thumb screw to operate at any underload or overload within its capacity.

The circuit may be opened while the motor is running by simply raising the small lever on the top of the solenoid, thus releasing the rheostat arm and allowing it to open the main switch. This method of opening a motor circuit through an increasing resistance is preferable to opening a switch carrying the normal armature current, as the main switch is opened at practically zero current and consequently there is no arc at the switch. The shunt field circuit is not broken by this method, but is added to by the starting resistance which is thrown in series with it when the rheostat arm is released.

◆

OIL SWITCHES.

The increasing use of high voltages has naturally led to many problems in switching, and in the solution of those the oil switch has come to the front. Of this type of switch we illustrate one of the latest forms made by the General Electric Company.

The form of switch shown is electrically opened and closed by hand. All of the live parts are supported from a single base or frame which constitutes the top of the switch, and the complete switch may be attached to any appropriate support as a single piece of apparatus. The mechanism consists of one or more metal contact pieces, depending upon whether the switch be single, or double, or triple pole. Each contact piece is carried upon a rod of specially treated wood. The rod or rods are connected to a cross-head, which, when operated by the system of levers, moves in a vertical plane. The clips with which the contact pieces make connection are supported from the frame by porcelain insulators thoroughly insulating all live parts. The switch is closed when the contact pieces are in their upper position, and in opening the switch these contacts drop into the lower portion of the oil can. The clips, contact pieces, and all exposed live parts are completely submerged in oil when the can is in place. No leads are introduced through the oil can, therefore there is no opportunity for leakage and no difficulty in the removal of the can.

The switch is not designed to rupture loads under emergency conditions, such as a short circuit immediately beyond the switch on the load side, which can exceed 5,000 kw., single-phase, or 8,500 kw., three-phase. They should not be mounted directly upon the panel for use on circuits which under emergency conditions can exceed 2500 kw., three-phase, or 1500 kw., single-phase. Conditions may exist which will render the use of this type of switch mounted directly upon the panel permissible in connection with circuits which under emergency conditions may somewhat exceed 2500 kilowatts, but such use should not be attempted without inquiring as to the advisability of it under the conditions contemplated. For service in connection with circuits which under emergency conditions can exceed 2500 kw., three-phase, or 1500 kw., single-phase, single-pole switches are generally used, each pole being placed in a separate fireproof compartment.

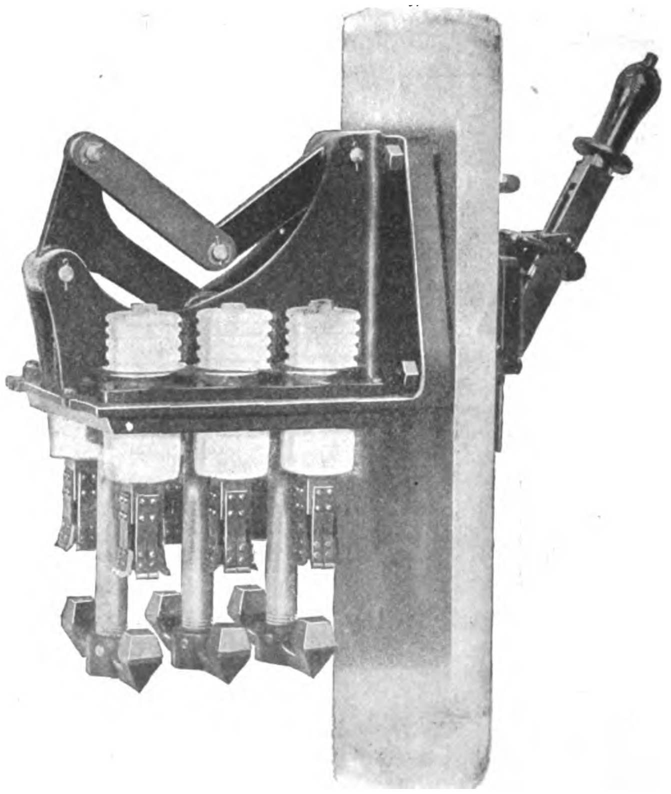

FIG. 1.—OIL SWITCH, ELECTRICALLY OPENED, CLOSED BY HAND.

To make the switch automatic and to have it perform the functions of an automatic circuit breaker, two forms of tripping mechanism are employed. The type selected depends upon whether the switch is installed directly upon the switchboard or in cells at a remote point. The first, or switchboard tripping mechanism, is shown in Fig. 1. It consists of a set of coils upon the face of the board (the edges of which are visible on the cut) operating armatures which actuate a release catch on the link connecting the switch and the handle. The tripping coils are energized from the secondaries of current transformers connected in series with the main circuit of the switch. When the switch is thrown open automatically by means of the tripping coils, the operating handle on the face of the board remains closed, the link moving forward through the handle. This movement serves to indicate that the switch has automatically opened.

New Apparatus and Appliances

MARSHALL-SANDERS SNAP SWITCH.

Fig. 1 herewith shows a new five-ampere snap switch manufactured by the Marshall-Sanders Company, of Boston, Mass., which contains several novel features. The working parts are made of nickel-steel, while the snap spring is made of Tungston steel. The contacts are of very ingenious design, the lower part being formed of one piece of metal and the contact post setting down into the porcelain. Over this is a stiff but flexible bronze spring contact which forces the moving contact which is loosely pivoted on the catch plate, down onto the soft metal part of the contact. The cover is lined with a seamless drawn cup of fibre, which is a decided improvement over the paper linings heretofore used. A feature of the switch is the handle, which is said to be almost unbreakable.

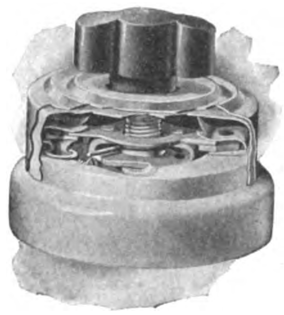

FIG. 1.—SNAP SWITCH.

GUY ANCHOR.

The two types of guy anchor shown by Figs. 2 and 3 herewith are made by W. N. Matthews & Bro., of St. Louis, Mo., and are said to have an extended use in the West. The anchor shown by Fig. 3 is used on straight line work and on curves where there is not a great strain. Fig. 2 shows a larger type which is employed for heavy dead-ends and corner strains, and for smoke stacks, bridge and trestle work where a great strain is encountered. The advantage of the design is that either anchor can be placed in the ground without digging, filling or tamping, the anchor being practically in one piece. An actual test with a 5-in. anchor of the smaller type having a 3/8-in. wrought iron rod is said to have required a pull of 8,000 lbs. to dislodge it in a hole bored three feet into a sandy soil, with a correspondingly greater pull when it was embedded in clay. A 12-in. guy anchor is said to have withstood a pull of 36,000 lbs. when embedded in five feet of clay. The anchors are bored into the ground without otherwise disturbing it, in much the same manner as a wood screw is fastened into a board, and this is said to account for the great force necessary to dislodge them.

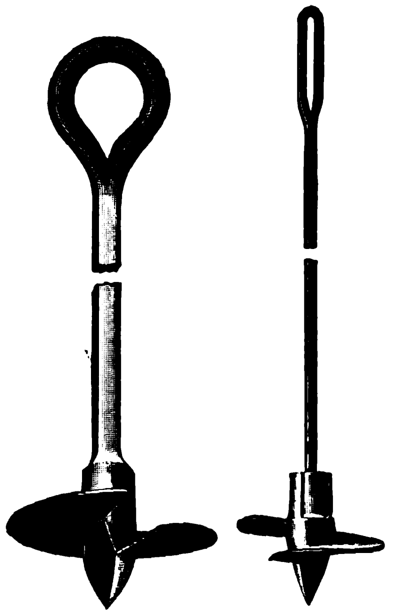

FIG. 2.—GUY ANCHORS.—FIG. 3.

THE BRANCH STEAM TRAP.

Fig. 4 herewith illustrates the working parts of the Branch steam trap manufactured by the National Oil Burner and Equipment Company, of St. Louis, Mo. Referring to the illustrations, it will be seen that the construction of the trap is very simple, its action being based on a system of double levers. The trap consists of a cast-iron cylinder with a heavy flange at the upper end to which is bolted the cap of the trap. This cap is constructed so as to permit of either a vertical or a horizontal inlet for the steam. The working parts consist of a system of double levers operated by means of a cylindrical float having semi-spherical ends through which passes loosely a spindle having a valve at its lower end, and a nut at its upper end which is acted upon by the levers. The sensitiveness of the trap is apparent. The level of the condensation when the float is about to lift the valve, is 11 inches above the bottom of the float which insures a good supply of water in the trap at all times. As soon as the water drops slightly below this level, the valve will close. It is claimed that by the employment of the Branch system of double levers the lifting force of the float is increased five times. The valve is provided with a removable seat and the trap is designed to work successfully under all pressures up to 250 pounds, and to deliver water against any back pressure not exceeding 3 pounds less than the pressure of steam in the trap. The trap being always supplied with sufficient water of condensation, an effective seal is provided which renders the escape of steam impossible. The traps are furnished with water glass gauge and blow-off cocks and are suitably tapped for any size of pipe.

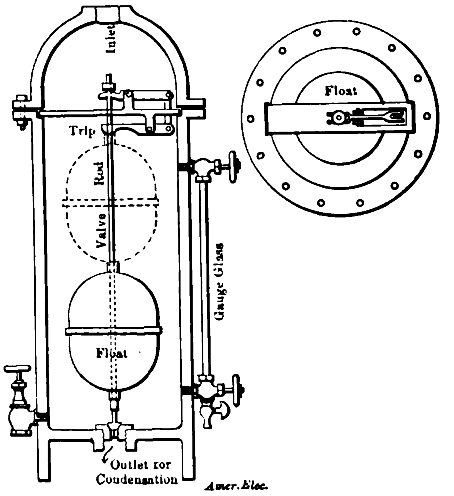

FIG. 4.—BRANCH STEAM TRAP.

THE WEBSTER CLASS C HEATER AND PURIFIER.

The accompanying illustration shows the "Class C" type of Webster heater which has recently been placed upon the market to meet the requirements of those who desire a feed water heater of small to medium size in combination with a filter, the filter being added to make the heater particularly adapted for a feed water containing mud and salts of lime, magnesia, etc. The heater is of the open type and is in general somewhat similar to others of the same make. The feed water enters the heater through an inlet at the top and discharges into and fills a trough forming a water seal, the purpose of which is to prevent water hammer. The water overflows from the trough over a series of inclined perforated heating trays of copper, and in its downward course becomes heated by steam in the heater, the water falling upon a division plate separating the heating and filtering chambers. The filter is located in the lower casing. After the water is heated it passes through a pipe into the settling chamber at the bottom of the heater, where precipitated salts and impurities collect. The water then rises through cast-iron perforated screens which hold the filtering material in place, through the filtering material and a number of screens to the under side of the division plate, whence it travels to an outlet leading to the boiler feed pump. The purpose of employing the upward method of filtration is to separate from the feed water all the precipitated salts and impurities that can be removed by sedimentation so that the filter has only to deal with the lighter

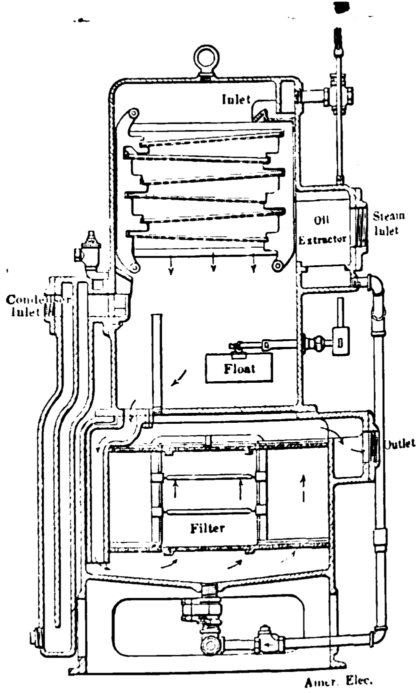

FIG. 5.—WEBSTER HEATER AND PURIFIER.

impurities. As in other heaters of the Webster type, the admission of cold water is controlled by a float so that a constant level is maintained in the chamber below the inclined screens. The returns from the heating coils, steam engine jackets, reheating receivers, etc., are carried into the heater through a connection at the side provided with the water seal. Means are provided for relieving the heater of air, and a Webster oil separator is provided in the connection through which exhaust steam is admitted. The trip from the separator is connected to a blow-off pipe leading from the bottom of the heater. The makers of the heater are Warren Webster & Co., of Camden, N. J.

PENBERTHY FORCE FEED LUBRICATOR.

Fig. 6 shows a force feed lubricator made by the Penberthy Injector Company, of Detroit, Mich., and designed for the economic and positive lubrication of valves, cylinders, bearings, etc., against pressure. The lubricators are at present made in 2 and 3 pint sizes, the oil reservoir being of glass, with top and bottom parts held together by studs. The top part supports the valves in the center of the oil reservoir, which prevents them from being affected by severe changes of temperature. The valves can be taken out for inspection by removing the top part of lubricator. By removing a plug in the bottom of the reservoir the lubricator can be cleaned without disturbing the connections. The special point about this cup is the roller bearing driving mechanism, which renders the cup sensitive to the slightest motion, so that it can be attached to any vibrating or reciprocating part of an engine or other machinery, and will operate equally well whether the part is moving at a low or high speed. The flow of oil is controlled by three automatic valves, which prevent any back pressure coming on the cup. The plunger action is said to be positive, and the cup is designed for either light or heavy oils.

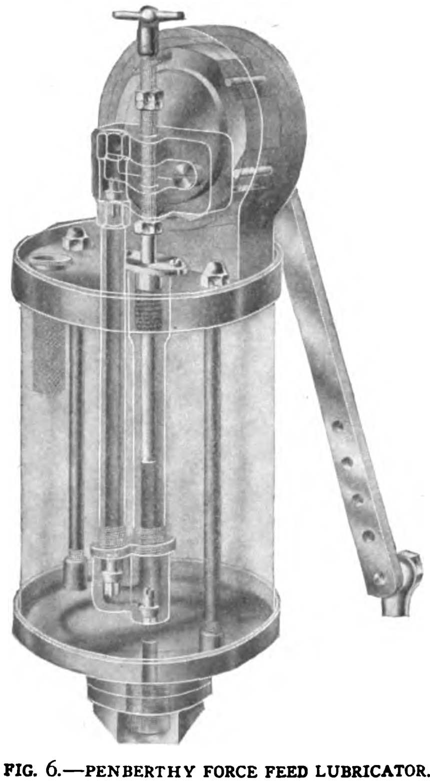
FIG. 6.—PENBERTHY FORCE FEED LUBRICATOR.

STORAGE BATTERIES WITHOUT JARS.

Fig. 7 herewith illustrates a novel storage battery brought out by the Smith Storage Battery Company, of Binghamton, N. Y., which is a radical departure from the beaten path of battery manufacture in its style and form. The battery embodies no new principles, the active materials being lead plates and dilute sulphuric acid; but the usual jars are dispensed with altogether, the lead plates themselves holding the electrolyte. The gridded plates are formed into oblong trays, and in making up one of these batteries any desired number of trays can be nested on top of each other, separators of perforated sheets of hard rubber or other suitable acid-proof material keeping the trays from contact with each other. As nested, there is sufficient space between the trays to hold the electrolyte which is in contact with the bottom of the tray above it, and with the inside of the one which holds it. This permits of a chemical action on the upper side of one plate and the under side of the one above it. In preparing the plates, the under side of each tray is chemically treated to become oxide, and the upper side peroxid of lead. This makes the upper side of each tray the positive and the under side the negative, of what in other batteries would be a single cell. By adding another tray to the nest the potential is increased by two volts, the same as adding another cell to an ordinary battery. The under side of the bottom tray and the upper side of the upper tray are plain and are inactive. The voltage of any battery will therefore be twice one less than the number of trays; thus, a battery of eleven traps will give 20 volts. For regular work there is no connection between the plates of the battery, except the electrolyte, the use of jumpers between the plates being unnecessary. The negative terminal is connected to the top of the upper tray, and the positive terminal to the top of the bottom tray. It is possible, however, to obtain any combination of series-multiple or multiple-series connections by attaching terminals to as many of the trays as desired and cutting in or out additional trays as the service demands; thus a connection from the top of the 3rd and the bottom of the 7th trays will give current at 8 volts, and the potential beween the upper side of the 5th and the under side of the 12th will be 14 volts. One of the advantages claimed for this type of battery is its low internal resistance. Its charge is said to be at all times from the entire surface of all of the plates, and it is claimed that therefore it makes little difference as to the rapidity with which the battery is charged or discharged, or how changeable may be the demands for current, since there is not the slightest danger of buckling. The arrangement of the trays obviates a trouble frequently met with in storage batteries, that is, the deposit in the bottom of the jars of active material which is liable to cause a short circuit between the plates. Since such deposits usually come from the positive plate, and since with this battery, the positive plate is the upper side of the tray there is no tendency for this loosening, and all particles which become free in this manner will lie just where they were before without danger of causing a short circuit.

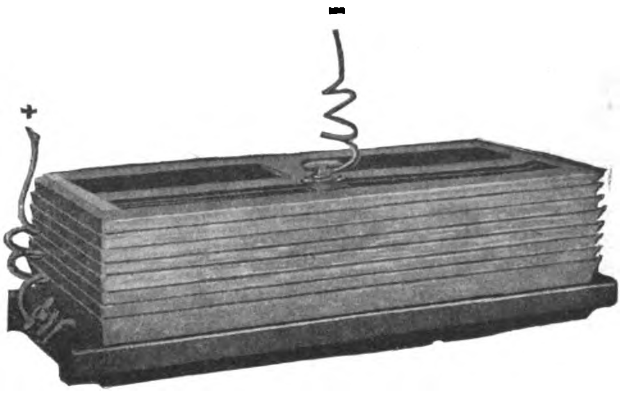

FIG. 7.—SMITH STORAGE BATTERY.

COMBINATION RIP AND CROSS-CUT SAW AND ATTACHMENTS.

The illustrations herewith show a combination self-feed rip and cross-cut saw and moulding and boring attachment for the same. The machine is operated by foot and hand power, or it can be run by motor power. By their particular construction it is adapted to the requirements of electrical workers for making boxes and finishing the wood work of electrical apparatus, etc. The saw has a strong and rigid iron frame, cold rolled steel shafts, with hand-scraped babbitt metal-lined boxes, adjustable to take up the wear. The combination wood and iron table top is 28 inches wide by 36 inches long; the middle portion (10 x 36) is of iron, planed perfectly true. The table is hinged at the back and can be adjusted up or down by a hand-screw in front for babbetting, grooving, dadoing, etc. The self-feed ripping device is self-adjusting for all thicknesses of wood, and is positive in its action, the power being trans-

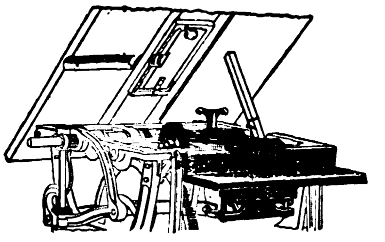
FIG. 8.—BORING ATTACHMENT.

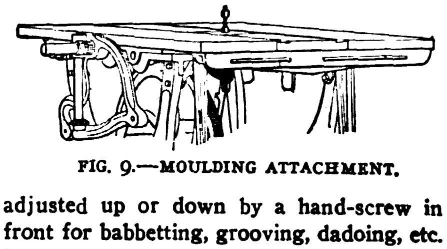
FIG. 9.—MOULDING ATTACHMENT.

mitted by gears. The self-feed has three changes of speed, and the device is easily detached, leaving the table free for cross-cutting, etc. The extension rolls increase the length of the table to seven feet, and they can be instantly folded down out of the way when not in use. The table is provided with two hand powers, both arranged to allow the operator a natural, upright and easy position. The hand power, at the rear of the machine, leaves an entirely free table for cross-cutting, dadoing, etc. Power is transmitted entirely by automatic machin-cut gears and chain belts, running smoothly. It is claimed that with this machine one man can easily rip soft wood up to 3½ inches thick, and hard wood to 2 inches, doing the work of four men with common hand saws, and that it is equally valuable for cross-cutting, mitering, etc. The boring attachment has an adjustable sliding table and stop to gauge the depth of hole. The scroll saw attachment can be quickly placed in position on the machine, making a strong and serviceable scroll saw, with large capacity. It will cut up to three inches thick and swing 24 inches. It has adjustable saw clamps, the wooden arms being mounted on pivot rocker plates. The moulding attachment is designed for edge moulding, beading, etc., on either straight, curved or irregular work. The spindle has a vertical adjustment for different thicknesses of work, and is made to rotate in either direction to suit the grain of the wood. The machine with its attachments is made by the Seneca Falls Manufacturing Company, of Seneca Falls, N. Y.

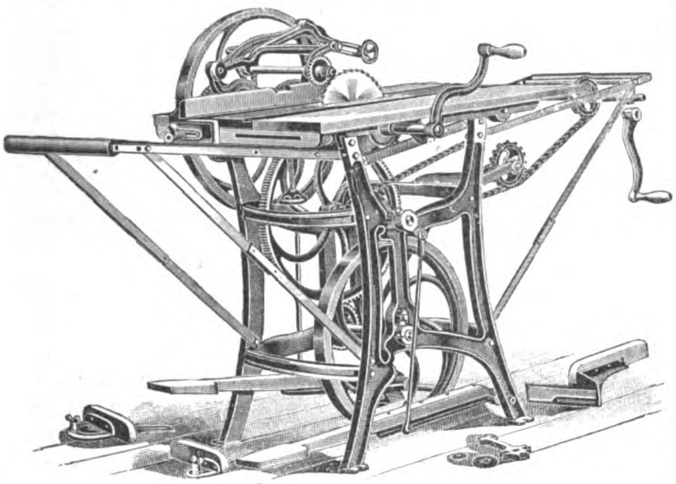

FIG. 10.—COMBINATION SELF-FEED AND CROSS-CUT SAW.

NEW INTERCOMMUNICATING TELEPHONE.

The De Veau Telephone Manufacturing Company, of New York City, has brought out a new switchless, automatic, intercommunicating telephone, various forms of which are shown in the accompanying illustrations.

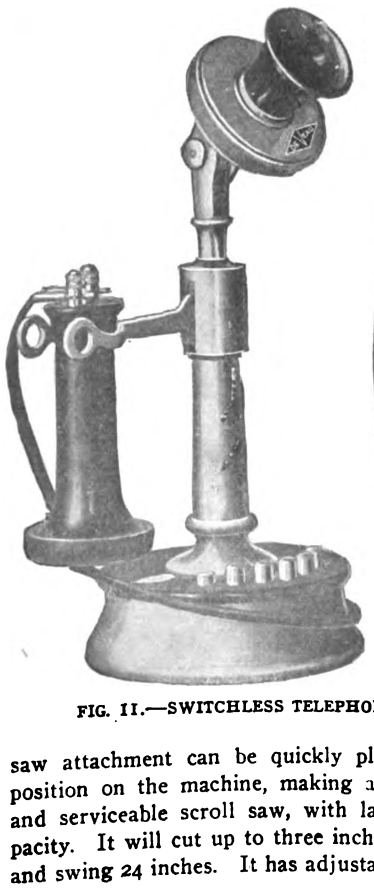

FIG. 11.—SWITCHLESS TELEPHONE.

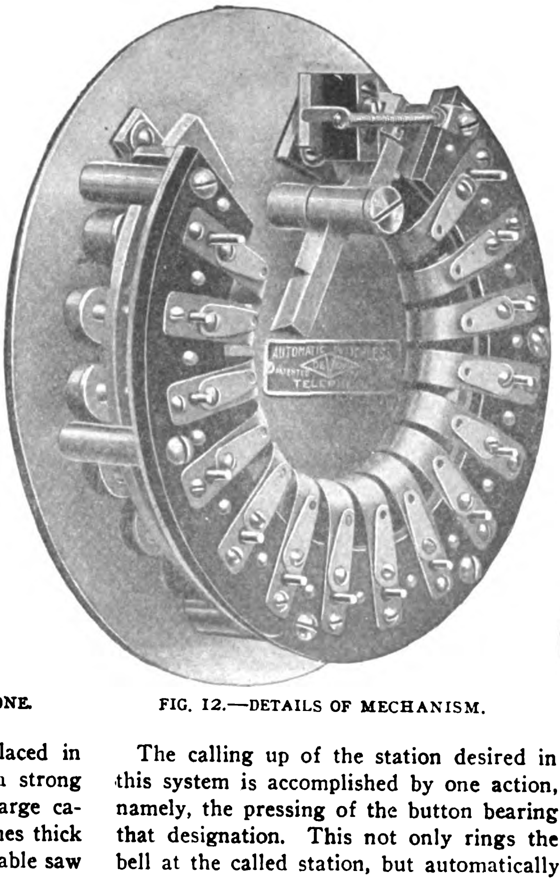

FIG. 12.—DETAILS OF MECHANISM.

The calling up of the station desired in this system is accomplished by one action, namely, the pressing of the button bearing that designation. This not only rings the bell at the called station, but automatically selects the wire of the individual desired; the connection being private, and remaining set until the receiver is hung up, when the circuits are returned to normal by the releasing of the button. The release of the button is accomplished by means of a very ingenious apparatus, shown in Fig. 11. In this, the receiver hook engages a release which allows the button, which had hitherto remained depressed, to come back to its normal position. As will readily be seen, this does away with the switch, which had to be returned to zero before the circuits were rendered normal. All the De Veau telephones are now equipped with the company's new transmitter, which is of the Bell solid-back type. The receivers are of the double-pole solid type, which the De Veau Company make a specialty. In these receivers the outer shell is cast around the magnets so as to make a solid, permanent adjustment, which construction gives its freedom from all troubles caused by expansion and contraction. Fig. 13 shows also the all-metal, flush type of the De Veau automatic, switchless telephone; here the nickel-plated front is flush with the wall so as to be out of the way, and at the same time is

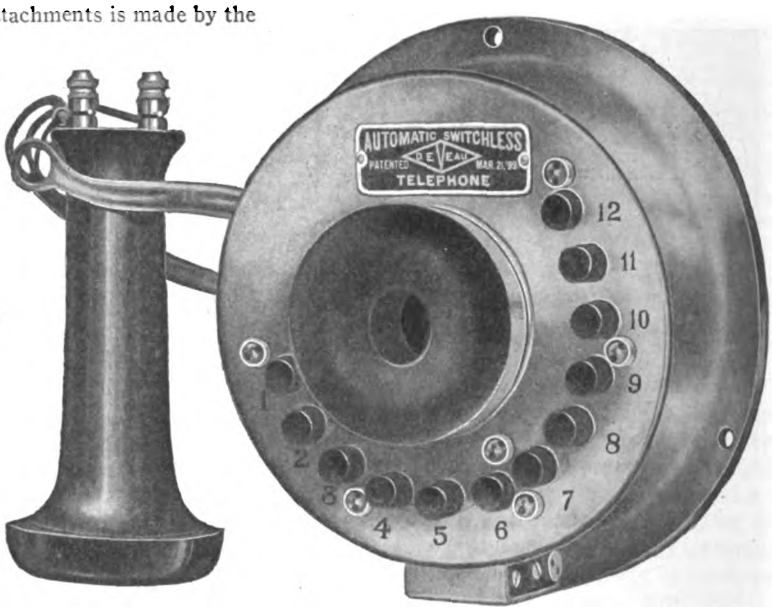

FIG. 13.—ALL-METAL SWITCHLESS RESIDENCE TELEPHONE.

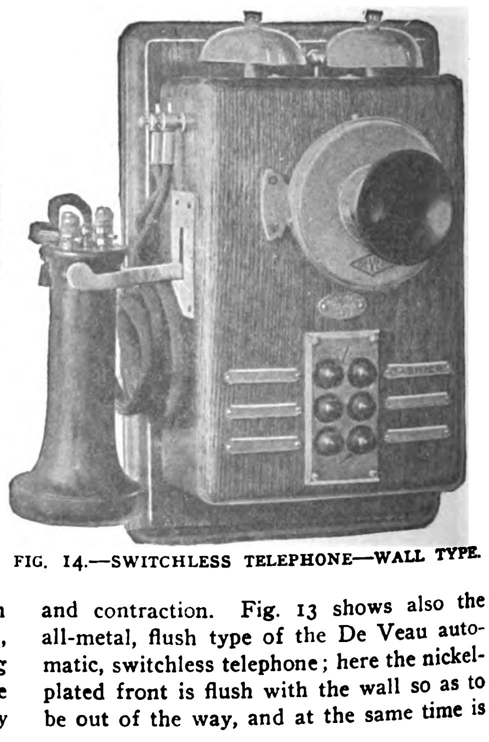

FIG. 14.—SWITCHLESS TELEPHONE—WALL TYPE.

attractive in style. The details of the connecting mechanism are shown by Fig. 12.

AUTOMATIC ELECTRIC BLUE-PRINTING MACHINE.

We illustrate herewith an automatic electric blue-printing machine manufactured by the Eugene Dietzgen Company of Chicago, Ill., which will be of interest to engineers not only because of its applications to the needs of the drafting room, but also of the peculiar working features of the device. The apparatus consists of a cylindrical printing frame composed of two heavy curved plates of glass embedded in soft material in an adjustable, though rigid frame, together with tubular uprights which support the arc lamp and automatic driving mechanism. The cylindrical frame revolves on trunnions, so that it can be swung to a horizontal position which is most convenient for inserting or removing tracings and paper from the frame. In operation, the cylinder is revolved to a horizontal position and the tracings and sensitized paper are placed around the outside of the cylinder, being confined by stout canvas covers which are drawn tight by turning a lever, thus ensuring perfect contact between tracings, sensitized paper and the glass. The cylinder is then swung to the opposite horizontal position and the same manipulation repeated, after which it is returned and locked in a vertical position ready for printing. By touching a lever the arc lamp starts in its descent through the center of the cylinder at a speed which can be regulated to suit the sensitiveness of the paper employed. When the lamp has reached the lowest point of printing surface, it automatically reverses its position and quickly returns to its original position above the cylinder. The lowering and raising of the arc lamp is accomplished in the following manner; the lamp is connected with the piston of a hydraulic cylinder, and to lower the lamp, oil is discharged from the cylinder through a small valve, the speed of the descent being controlled by the flow of the oil which can be regulated at will by a small thumb screw. When the lamp has reached its lowest position, a trigger on the piston presses a star switch which starts a small motor shown on the back of Fig. 15. This motor pumps the oil back into the hydraulic cylinder, which results in the quick ascent of the lamp. A trigger pressing on another switch stops the motor when the lamp has reached its proper position above the cylinder. The downward movement of the lamp can be regulated to take from five seconds to one hour, and the limit of the motion of the lamp can also be regulated according to the size of the prints. The claim is made that the cost of making blue-prints by electric light is less, where the full capacity of the machine is utilized, than by the use of sunlight, the average allowance being made for wasted material under the ordinary method due to overprinting, etc., with attendant loss of time. The machines are made in four sizes and may be had with or without the automatic mechanism.

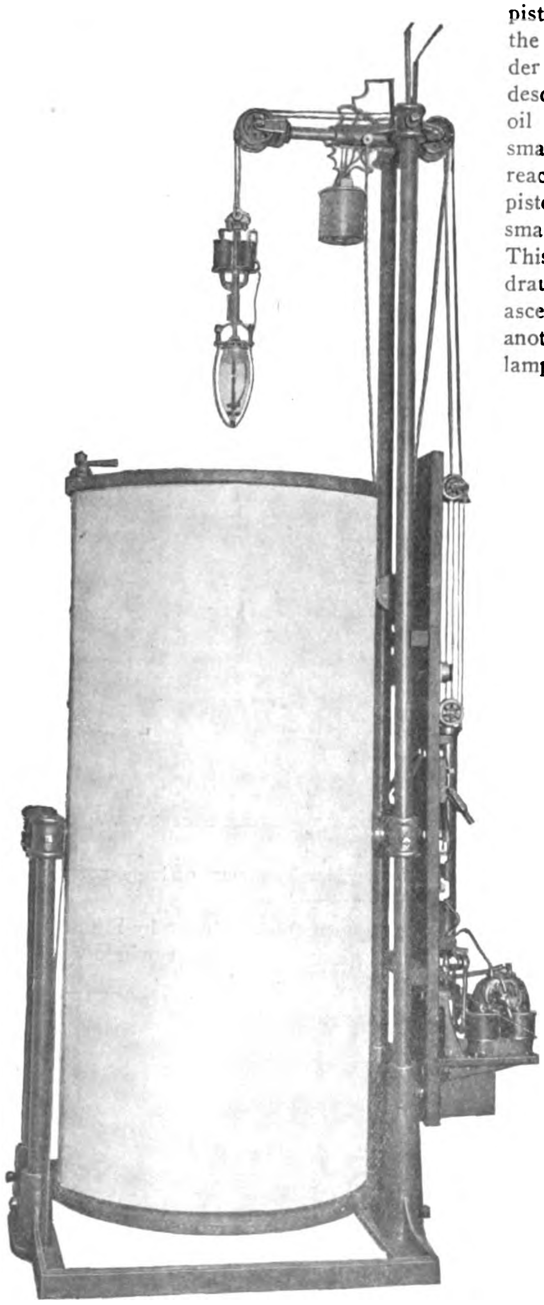

FIG. 15.—ELECTRIC BLUE PRINTING MACHINE.

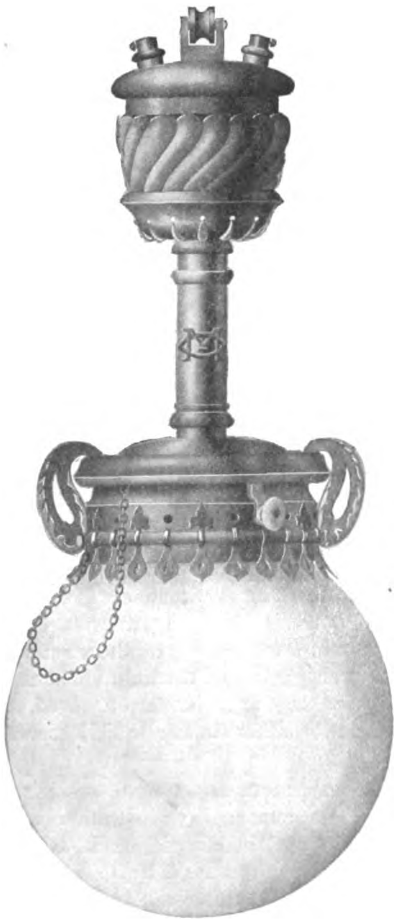

FIG. 16.—O-M ARC LAMP.

"O-M" ARC LAMPS.

The Osbor -Morgan Company of Cleveland, Ohio, have embarked into the field of arc-lamp manufacture, and have recently placed upon the market a line of "O-M" enclosed arc lamps. The lamp is shown in section by Fig. 7 herewith. In the head of the lamp within the canopy is the solenoid which is made accessible by lowering the canopy, and this is accomplished by releasing the set screws. The armature is connected directly to the clutch by means of a metal rod and forms part of the plunger of the graphite dash-pot which is located in the center of the magnet. The resistance is fastened around the base of the lamp out of view, but exposed directly to a current of air, and protected from the weather. The clutch operates directly on the carbon, the part in direct contact with the carbon being made of insulating material which insures a steady clutch hold and freedom from burning out. In the base of the lamp and readily accessible, is the lamp switch. The connection for the carbon is made by means of a flexible cable, thus eliminating all sliding contact. The inner globe is pear-shaped and is open only at one end, being firmly held against the porcelain base by a spring,

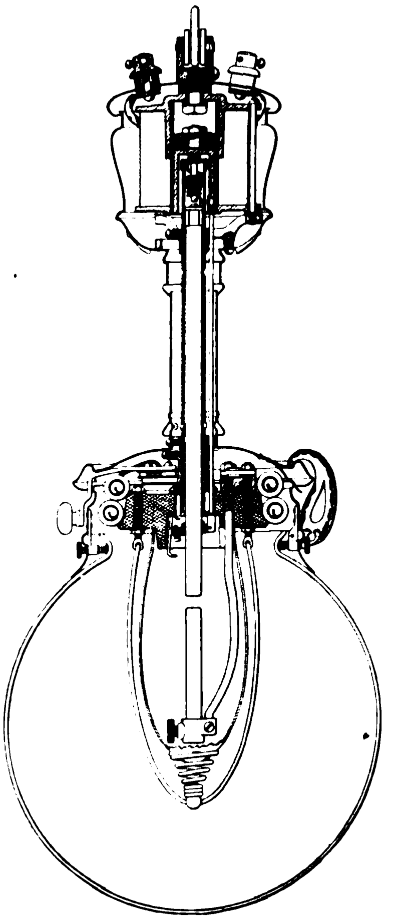

FIG. 17.—O-M ARC LAMP.

The outer globe is spherical in shape and is held by a globe-ring to the lamp base. The binding posts are at the top of the lamp, safely separated and insulted from the case by porcelain insulators. They are also marked *P* and *N* so that the lamp may be properly connected to the circuit. The 110-volt lamps operate on a constant-potential circuit having a pressure from 90 to 130 volts and consume from 4 to 5 amperes. The 220-volt lamps operate on a constant-potential circuit having a pressue of from 220 to 230 volts and consume from 2½ to 3 amperes. Fig. 16 shows a lamp for interior and exterior use. All of the lamps made by this company are provided with a waterproof case.

WALL CASE FOR FLUSH SWITCHES.

The Hart & Hegeman Manufacturing Company, of Hartford, Conn., has brought out a new wall case for installing flush switches in old walls, which will be found of value by contractors and wiremen who have occasion to wire old buildings. The cases are made in gangs—horizontal, vertical or tandem style, as desired—and are fitted with plates which completely cover the opening in the wall. Fig. 18 shows the case and Figs. 19 and 20 show cases with switches in place; the former showing a push switch and the latter a rotary switch. Each case is provided with two holes in each end for ¼-in. flexible conduit, and four holes are provided in the bottom or back of the case for ⅜-in. flexible conduit. These holes are securely plugged and each is furnished with a round bushing in order that the sharp edges of the box might not injure the insulation on the conduit or wire as the case might be. Other constructional features are clearly indicated in the engravings.

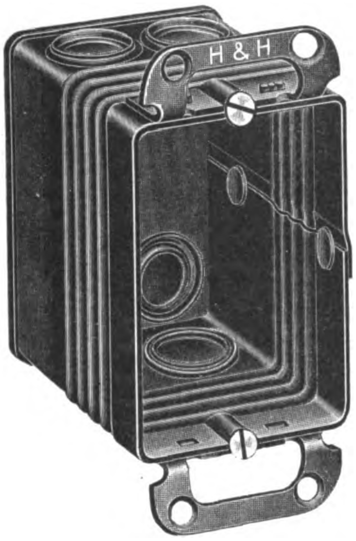

FIG. 18.—WALL CASE.

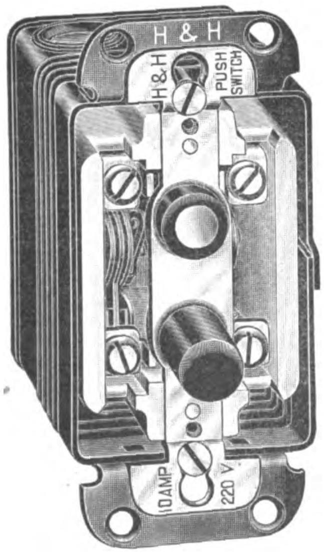

FIG. 19.—PUSH SWITCH.

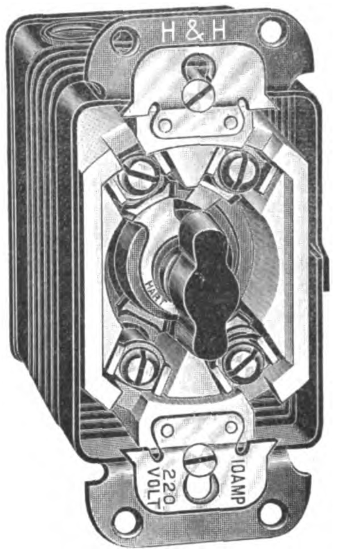

FIG. 20.—ROTARY SWITCH.

COMBINED SOCKET AND REFLECTOR.

Fig. 21 herewith shows a combined socket and reflector brought out by the H. T. Paiste Company, of Philadelphia, Pa. The combination is made in both the pendant and bracket types, and is composed of a porcelain water-proof socket provided with a petticoat. This petticoat acts as the reflector and it is also claimed serves to keep soot and rain from lodging on the lamp and thus absorbing much of the light. The socket is known as the P-K deep-grooved, and is made for either Edison or T-H bases.

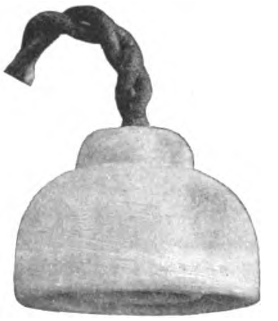

FIG. 21.—SOCKET AND REFLECTOR.

NEW PORCELAIN ELECTRIC SPECIALTIES.

The accompanying illustrations show various porcelain electric specialties recently brought out by Pass & Seymour, of Sobray, N. Y. Fig. 22 shows a porcelain junction box or transformer cut-out, which is especially adapted for use in electric light stations and isolated plants. It is finished in two styles, one style having a white glazed finish, while the other style is provided with a black enamel finish. This latter finish is not merely thrown on, but the cut-outs are dipped and are then baked; resulting in a finish which will stand the weather and which is at the same time pleasing in appearance. Its chamber is entirely surrounded by porcelain, and is completely divided by means of projections on the plug. The plug is held in the back by means of knife contacts capable of holding a wire from the smallest size up to No. 4, and also capable of taking a 5-in. fuse. The cut-out is fastened into place by means of lag screws furnished by the makers.

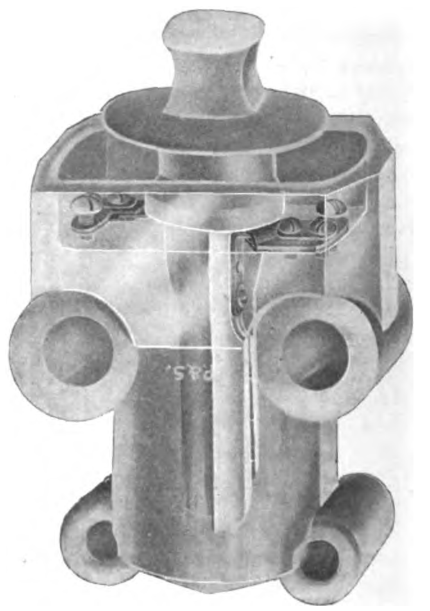

FIG. 22.—JUNCTION BOX.

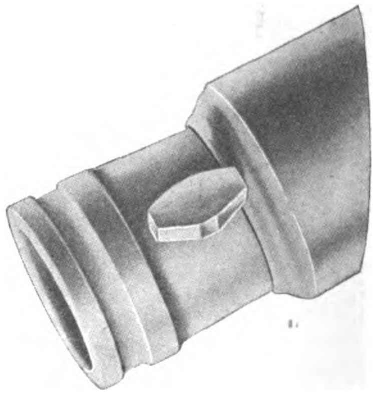

FIG. 23.—ANGLE RECEPTACLE.

The angle receptacle shown by Fig. 23 was especially designed for show window work and possesses many features of advantage not found in the ordinary receptacle. By its use, a downward distribution of light is obtained. It is made both with and without a key, and can be used with either concealed

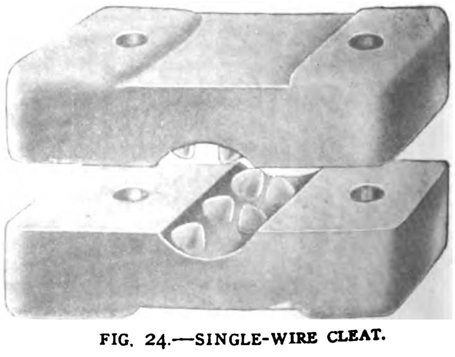

FIG. 24.—SINGLE-WIRE CLEAT.

or open wiring. It is designed as the illustration shows for a shade holder.

The single wire cleat shown by Fig. 24 is strong and durable. It is made in two sizes and both glazed and unglazed. It will take wire in sizes from No. 14 to No. 2, and is so designed that when put in place the wires cannot slip and the insulation of the same is preserved.

The switch base shown by Fig. 25 was designed to take the place of the small knobs which have been used heretofore quite frequently in putting up surface switches on open cleat work. The base may be used with any five or ten ampere switch with either a single or double pole. The strain insulator shown by Fig. 26 is made in two sizes, one to take a wire as large as ⅜ in. in diameter, and the other to take a wire as large as ½ in. in diameter. Strength is the principal characteristic of the insulator and it is warranted to withstand the breaking strain of any of the wires mentioned.

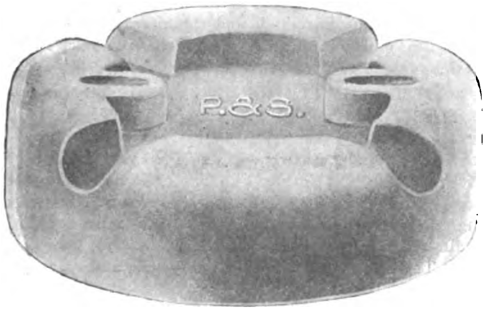

FIG. 25.—SWITCH BASE.

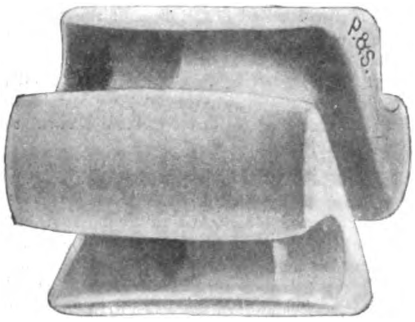

FIG. 26.—STRAIN INSULATOR.

NEW BOOKS.

THE PROFESSOR ON SHIPBOARD. By C. A. McAllister. New York: Marine Engineering. Cloth; 103 pages, 4½ ins. by 7 ins.; 2 illustrations. Price, $1.

This is a rather interesting narrative, purporting, as the title indicates, to relate the experiences and observations of a professor of engineering during a sea-voyage. The trip taken by the Professor was to South America, and it is from his conversations with the engineers and firemen, together with his mental comments on the means and methods found on shipboard, that the reader obtains the engineering information that the author seeks to impart. The book is rather more interesting than instructive, but is not without value to youngsters having aspiration to membership on a marine engineer's staff.

ELECTRICITY AND ITS SIMILITUDES. By C. H. Tyndall. New York: Fleming H. Revell Company. Cloth; 215 pages, 5 x 8 ins.; occasional illustrations. Price $1.

Like the culinary preparation commonly known as hash, this book is most excellent for anyone desiring that kind of pabulum. The similarity between the dish and the book extends also to the composition of the two; the contents of the book being a curious mixture of "popular science," scientific, quasi-scientific and biblical quotations, and religious platitudes, with an occasional saccharine dash of poetry. Bishop Potter will undoubtedly enjoy the analogy drawn between his having passed several years with an internally injured foot (the injury having been finally revealed by Röntgen rays) and the cry of the psalmist David: " * * * * * * * * * neither is there any health in my bones because of my sin"! There may be, and doubtless are, sporadic points of interest in the book; a taste of the first few chapters deterred the reviewer from further investigation.

ELECTRICAL CATECHISM. Reprinted from *Power.* New York: Hill Publishing Company. Buckram; 210 pages, 5½ ins. by 9 ins.; 246 illustrations; numerous tables. Price, $2.

This is a very meritorious addition to the list of electrical catechisms, but it is marred to some extent by several errors of one kind or another. The author obviously is fully familiar with electrical engineering, so that it is only fair to attribute the inaccuracies to carelessness or haste—which is equivalent in a case of this sort. The worst of these inaccuracies is the inversion of the mechanical equivalent of heat, which occurs on page 31, where a foot-pound is said to be equivalent to 778 heat units, instead of the reverse. It would be absurd to assume that the writer of the book knew no better than this, and it is regrettable that its revision was not more carefully performed. The errors noted by the reviewer, in addition to the one on page 31, are: Page 30, *"S"* should be *"Rev."*, and "9" in the denominator of the first fraction should be "0"; page 31, "1055-1625" should be ".174" (involved in the inversion of heat units and foot-pounds); page 200, "½ ohm" should be somewhere around 200 ohms, and "1 ohm" should be about 400 ohms. It may be rather captious to characterize the chapters on the incandescent and Nernst lamps as being much too brief and cursory, but that is the impression gained by the reviewer. Except for the inaccuracies above cited, the information contained in the book is reliable and thorough, and should be of much value to beginners who care for the "query and answer" mode of instruction. The presswork is good and the illustrations are far superior in conception and execution to the kind usually found in elementary books.

[It is only fair to state that some of the errors mentioned were corrected on an "Errata slip" overlooked by the reviewer.—EDITOR.]

LEGAL NOTE.

SOCKET AND RECEPTACLE PATENTS.—Perpetual injunctions have been issued against the Genesee Electric Company for infringement of the Rochester socket and receptacle patent owned by the General Electric Company.

PERSONAL.

MR. NORTON P. OTIS, chairman of the board of directors of the Otis Elevator Company, has been elected United States Congressman for his district.

MR. D. E. GOE, recently advertising manager for the Northern Electrical Manufacturing Company, has resigned his position there and will devote his energies to general advertising work.

MR. W. F. GUNN has been appointed manager of the advertising and publicity department of the Kellogg Switchboard & Supply Company, Chicago.

MR. F. L. MARTIN, formerly advertising manager for the Kellogg Switchboard & Supply Company, has accepted a similar position with the Stromberg-Carlson Telephone Manufacturing Company.

MR. W. C. WARD, who was for some time mayor of Warren, Ohio, has become executive head of the Peerless Electric Company, recently organized in that city and now engaged in the manufacture of electrical apparatus.

MR. J. W. YOUNG, secretary of the Allis-Chalmers Company, has been appointed general manager of the London offices of the company. He will be succeeded in the secretaryship by Mr. J. H. Seaman, the third vice-president of the company.

MR. ARTHUR STANLEY has been appointed manager of the New York office of the Robbins & Myers Company, Springfield, Ohio. This office is now located in the new Maiden Lane Building, at the corner of Broadway and Maiden Lane.

MR. L. F. MAHLER, Chicago manager for the Curtiss-Crippen Engineering Company, is paying special attention to the De Laval steam turbine, for which his company is agent in the middle west. Mr. Mahler's headquarters are at No. 1232 Monadnock Block.

MR. A. M. LITTLE, who has been connected in the past with the American Electric Company, Western Electric Company and Stuart-Howland Company, has joined the forces of Pass & Seymour, Inc., of Solvay, N. Y., and will represent that company in the factory territory.

MR. J. C. BELDEN, formerly connected with the Kellogg Switchboard & Supply Company, has gone into business for himself, having established the Belden Manufacturing Company, with headquarters at 118 Michigan Street, Chicago. The new company will make a specialty of magnet wire.

MESSRS. KERN DODGE and CHARLES DAY, of the firm of Dodge & Day, Philadelphia, have just returned from an extensive trip through the middle west, where they visited many of the principal machine shops, gathering data on shop efficiency and comparing factory methods. The firm makes a specialty of modernizing electric power plants..

MR. GEORGE F. PORTER, who made a host of friends and an enviable reputation in the insulating wire and cable field while connected with W. R. Brixey, recently severed his connection with that manufacturer to accept the position of sales representative for the Atlantic Insulated Wire & Cable Company, with headquarters at 120 Liberty Street, New York.

MESSRS. J. J. BELLMAN and HENRY SANFORD, JR., have engaged in general electrical engineering and contract work, with headquarters at 14 Church Street, New York. Both of these gentlemen are practical men and have been connected with several prominent manufacturing and operating companies. Mr. Bellman has had experience in the service of the Crocker-Wheeler Company, Westinghouse, Church, Kerr & Co. and the New York Edison Company; Mr. Sanford was formerly on the staff of the General Electric Company, and later in the employ of the Metropolitan Street Railway Company.

ROONEY - MEADOWCROFT - WESTBURY.—Mr. John Rooney, president of the Rooney-Westbury Electric Lamp Company, the organization of which is noted in another column, entered the electrical field in 1881, and was one of the organizers and the president of the American Electric Light Company; was one of the promoters of the Consolidated Electric Light Company, and the Sawyer-Man Electric Company, all of which were subsequently merged in what is now the Westinghouse Electric & Manufacturing Company.

Mr. William H. Meadowcroft, the vice-president of the company, came to the United States from Manchester, England, in 1875. Shortly after coming to America he studied law, and he was admitted to the New York bar in May 1881. He left the legal profession shortly after being admitted to the bar, and became identified with the old Edison Electric Light Company; he remained with the Edison Company and its successors over eighteen years, having been engaged in various departments of the companies. During the last six and a half years of his association with the General Electric Company he devoted his entire time to miniature and decorative lamps, a branch of the lamp department which he originally started in 1885. His love of the old work with decorative and miniature incandescent lamps has prompted his joining forces with Messrs. Rooney and Westbury, in the Rooney-Westbury Company. He is also treasurer of the Foreign Patents Company and of the American Stone Company.

Mr. Harry Westbury, the treasurer and sales manager of the company, graduated from one of the largest colleges in the west of England. On coming to this country he entered the employ of the General Electric Company at Harrison, N. J., and was associated with Mr. W. H. Meadowcroft in developing the manufacture and uses of the miniature lamp. His name has been intimately associated with the developments in Röntgen ray work for several years past. He is a prominent member of the Röntgen Ray Society, and has written interesting papers on various subjects pertaining to this branch of science.

Mr. Francis J. Rooney, the secretary of the company, is a mechanical engineer and a graduate of the Academic Department of the Polytechnic Institute of Brooklyn. He was for over two years assistant manager of a large manufacturing business in New York city and subsequently superintendent of an Electro-Therapeutic establishment.

Mr. John J. Rooney, the general manager of the company, is a graduate of the Polytechnic Institute of Brooklyn, being one of the first students to take the electrical engineering course established in 1893 by Dr. Samuel Sheldon. Mr. Rooney early devoted himself to storage battery work and perfected a type, which, however, he did not place on the market, owing to the patent situation. He then turned his attention to high tension electro-therapeutic work, and recently installed a large plant for this class of work in London.

TRADE PUBLICATIONS.

MONOPLEX TELEPHONES. Atwater-Kent Manufacturing Works, Philadelphia, Pa.—A nicely executed folder pointing out the advantages of the Monoplex telephone, and containing a diagram of connections for this compact little equipment.

LOSS. The Shelby Electric Company, Shelby-O.—A pocket-size pamphlet containing strong arguments in favor of the Shelby incandescent lamp, which, as is well known, gives considerably greater candle-power through the tip than is given by the ordinary form of filament.

THE KILKENNY CATS. New York & Ohio Company, Warren, O.—An amusing pamphlet pertaining to the incandescent lamp situation and the merits of the Packard lamp. This company now makes special lamps for sign work which deliver full candle-power through the end.

ELECTRIC LABORATORY FURNACES. Eimer & Amend, New York.—A pamphlet devoted to chemical furnaces, made in several sizes. the Moissan form of electric furnace, pyrometers of the Le Chatelier type, and electric heating apparatus for distillation purposes. All of the heaters and furnaces are of the electric type.

INDUCTOR TYPE ALTERNATORS. Royal Electric Company, Peoria, Ill.—A bulletin containing an interesting discussion on the inductor-type alternator in general and the form of machine built by this company in particular. The details of the machine are fully illustrated and described, and its merits clearly pointed out.

BUFFALO FORGES. Buffalo Forge Company, Buffalo, N. Y.—A handsomely executed pocket size catalogue of Buffalo down-draft, portable, stationary and heating forges for general industrial service. The catalogue also contains matter relating to tuyere irons, blower fans, and blast gates.

MECHANICAL INDUCED DRAFT. Buffalo Forge Company, Buffalo, N. Y.—A handsomely executed pocket-size pamphlet containing illustrations of typical mechanical draft installations made by this company, together with a concise and forcible presentation of the advantages of mechanical draft.

ELECTRIC HOISTS. General Electric Company.—This is publication No. 1041 and conforms in character and style to the high-grade standard of this company's literature. The catalogue is profusely illustrated with engravings showing every imaginable type of hoisting apparatus, operated by electric motors.

ELECTRICAL MERCHANDISE. Liberty Electrical Supply Company, New York.—A catalogue of general character, including in its scope annunciators, electric bells, telegraph and telephone instruments, and other domestic apparatus. The catalogue also includes price-lists of wire and construction tools.

WORK DONE. Westinghouse, Church, Kerr & Co., New York.—This is a most interesting publication to engineers in general, and railway engineers in particular. In its pages is described some of the more important work done by Westinghouse, Church, Kerr & Co., the grade of which is too well known to require comment.

MACHINISTS' HAND TOOLS. Brown & Sharpe Manufacturing Company, Providence, R. I.—A pamphlet catalogue devoted to B. & S. combination squares and protractors, protractors alone, and calipers. All of the tools are illustrated and described, and the text includes the usual data and price lists.

STEAM SEPARATORS. Austin Separator Company, Detroit, Mich.—This is catalogue No. 12, containing illustrations, dimensional data, and price-lists of the well-known vertical and horizontal Austin separators for both live and exhaust steam. The catalogue is well executed, and the engravings convey a thoroughly intelligible idea of the construction of the apparatus.

ELEVATING, CONVEYING AND TRANSMISSION MACHINERY. The Jeffrey Manufacturing Company, Columbus, Ohio.—This is catalogue No. 72, and its scope includes a complete line of chain belt, steel cable, and other forms of conveying apparatus; bucket and other types of elevating machinery; chain and sprocket equipment, cable chains, rubber belting, iron and wood pulleys, gears, etc. The catalogue is of very handy size, and nicely executed.

SWITCHES AND SWITCHBOARDS. McKenna Brothers' Brass Company, Ltd., Pittsburg, Pa.—A catalogue of standard size containing illustrations, descriptions and price-lists of switchboards, panel-boards, knife switches, and switchboard fittings, such as connecting lugs, tee and straight connectors, etc. The catalogue also contains price-lists of the standard Western and General Electric switchboard instruments, and I.-T.-E. circuit breakers.

TELEPHONES. International Specialty Company, Adrian, Mich.—A book of standard catalogue size containing a discussion of telephones in general and a detailed description of the Schwarze apparatus manufactured by this company; also comparisons between this apparatus and others differing from it. The book further contains some good advice concerning the installation and use of telephone equipment, and suggestions concerning rural telephone lines.

CECO ELECTRICAL MACHINERY. Christensen Engineering Company., Milwaukee, Wis.—This is catalogue No. 55 of this company, but is of course the first one devoted to the line of alternating-current and direct-current machinery which the company has recently put on the market. The catalogue is of standard size, beautifully executed and contains illustrations of the details of the apparatus which cannot fail to be of interest to prospective buyers.

QUEEN SELF-REGULATING X-RAY TUBE. Queen & Company, Inc., Philadelphia.—To any one interested in the operation of Röntgen ray apparatus this catalogue will be of intense interest and practical value. It contains much information concerning X-ray apparatus, in addition to a detailed description of the self-regulating tube mentioned in the title. A unique feature of the catalogue is the use of colored illustrations showing

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accurately the appearance of the tube under various operating conditions.

ELECTRICAL APPARATUS AND SUPPLIES. Electrical Material Company, Baltimore, Md.—A general catalogue of electric light and power apparatus, fittings, and supplies; line material and construction tools; domestic goods, such as bells, annunciators, etc.; incandescent and arc light specialties; telephone and telegraph instruments and supplies; indicating and recording measuring instruments; fan motors, etc. The Electrical Material Company is the Baltimore representative of the Nernst Lamp Company and of the Westinghouse Company, and is in position to supply Nernst lamps and Westinghouse apparatus with promptness.

◆

BUSINESS NEWS.

C. W. HUNT COMPANY, New York, announces that the Hunt conveyor has just been awarded the gold medal at the Düsseldorf Exhibition; this was the highest award of merit in its class.

THE SHELBY ELECTRIC COMPANY, Shelby, Ohio, has put on the market a remarkably simple and compact enclosed-arc lamp, which is built for both direct and alternating-current circuits.

THE BURT MANUFACTURING COMPANY, Akron, Ohio, has just closed a contract for four large special-style, Cross oil-filters to be used on four new battleships now being built for the United States Navy.

MOUND TOOL & SCRAPER COMPANY, St. Louis, Mo., offers free to engineers who are readers of the AMERICAN ELECTRICIAN, a sample scraping tool, provided the request be sent in during the present month.

THE KENNICOTT WATER SOFTENER COMPANY, Chicago, has found it expedient to establish a railroad department on account of the rapidly increasing demand for its apparatus on railroads. This department has been placed under the supervision of Mr. Wm. R. Toppan.

THE SAFETY INSULATED WIRE & CABLE COMPANY has removed its general offices to 114 Liberty Street, New York City, to which address all communications should be directed. The company occupies handsome and commodious quarters on the eleventh floor of the Engineering Building at the address mentioned.

THE OTIS ELEVATOR COMPANY, New York, recently received the contract for the elevator and dumb-waiter equipment of the new Astor Hotel, Longacre Square, New York. The plant will consist of seven electric passenger elevators, two electric servants' elevators, eleven electric dumb-waiters and three electric sidewalk lifts.

THE PITTSBURGH GAGE & SUPPLY COMPANY, Pittsburg, Pa., has been unusually rushed with work during the past month. Recent orders included 150-h.p. boilers for the Lincoln Fire Brick Company, Bolivar, Pa.; the American Porcelain Company, New Brighton, Pa., and the Keystone Mining Company, Leadville, Col.

SHULTZ BELTING COMPANY, St. Louis, Mo., recently completed important additions to its factory, and has also remodelled the old part of the factory throughout. The improvements made will enable the company to fill with the utmost promptness all orders for its high-grade belts and belt dressings.

THE CUTTER COMPANY, Philadelphia, Pa., has removed its head offices from Nineteenth and Hamilton Streets to 1728 Spring Garden Street, Philadelphia, to which address all communications should now be sent. The removal was made in order to increase the company's facilities and thus enable it to take care promptly of the flourishing business which it enjoys.

MARSHALL-SANDERS COMPANY, Boston, Mass., has established branch offices at Los Angeles and San Francisco, Cal., and at Seattle, Wash. The company is rapidly extending its representation, and expects shortly to have offices in all the principal cities of the country. It makes a special feature of promptness in filling orders, no matter how large the orders may be.

THE METROPOLITAN SWITCHBOARD COMPANY, New York, advises us that the report published recently to the effect that it had been absorbed by the American Union Electric Company was entirely incorrect. The denial of the report comes from Mr. T. J. Murphy, the president of the company, who states further that another report to the effect that his company had gone into a receiver's hands was also without foundation.

BROWN CORLISS ENGINE COMPANY, Corliss, Wis., has been favored with such a rapid increase in orders during the past six months that it has been found necessary to build a new foundry, which will be 116 feet x 350 feet in size. At the present writing the foundry is almost completed. The company announces that it has arranged to take up the manufacture of mining machinery, such as hoisting and pumping apparatus, air compressors, etc., in the near future.

THE CHICAGO FUSE WIRE & MANUFACTURING COMPANY, Chicago, announces that it has installed at Buffalo, N. Y., in connection with the Union Manufacturing & Specialty Company, a complete equipment for the manufacture of its well-known lines of fuse wire, fuse strip, fuse links and telephone and telegraph specialties. The headquarters of the company will remain at Chicago, but the Eastern factory at Buffalo will be in charge of competent men who are thoroughly trained in the details of the business.

THE ELECTRIC STORAGE BATTERY COMPANY'S ANNUAL CONVENTION was held in Philadelphia on October 13, 14, 15 and 16. On Monday, the 13th, the managers of the sales offices throughout the United States met at the factory and a tour through the works was hade. A luncheon was served at the factory, after which the staff of the company and the visiting managers of the branch offices adjourned to the Colonnade Hotel, where a number of interesting papers were read.

A WESTINGHOUSE GATHERING.—The district office managers of the Westinghouse Electric & Manufacturing Company, representing all of the principal branch offices of that company in the United States, recently spent a week at the offices and works of the company, this being the occasion of the usual annual visit. On the evening of November 19, a very enjoyable dinner was given in honor of the visitors at the Duquesne Club, at which the engineers and executive officers of the Westinghouse Company were also present.

THE S. E. I. COMPANY, Syracuse, N. Y., is sharing the general prosperity of the electrical industry. The company has moved into new quarters in the Hall & McChesney Building, and is now controlled by Mr. James W. Eager, who will hereafter devote his entire time to the manufacture of electrical instruments. Mr. Eager has made an excellent reputation in the dynamo and motor field, and the S. E. I. Company's voltmeters and ammeters have received commendation wherever they have been used; the new combination should prove extremely effective.

THE PELTON WATER WHEEL COMPANY reports having recently closed a contract with the Vancouver (B. C.) Power Company, covering three Pelton wheel units, whose combined capacity is 10,000 horse-power. The wheels are for direct connection to electric generators; the power to be used for electric railway and manufacturing purposes in the vicinity of Vancouver. As instancing the progress of electric transmission, it may be mentioned that the Pelton Company has under construction at the present time water wheels aggregating 30,000 horse-power—all of which are to be used in connection with electric transmission of power.

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The Chicago, Milwaukee & St. Paul Railway is now running solid trains of palace sleeping cars, dining cars (serving meals a la carte) and first-class day coaches, through from Chicago to Calumet, Houghton, Hancock and other points in the Copper Country without change of cars, with direct connection for Marquette, Negaunee, Ishpeming, etc., and passengers from the East, South and Southwest will find this a most desirable route.

All coupon ticket agents sell tickets via the Chicago, Milwaukee & St. Paul Railway.

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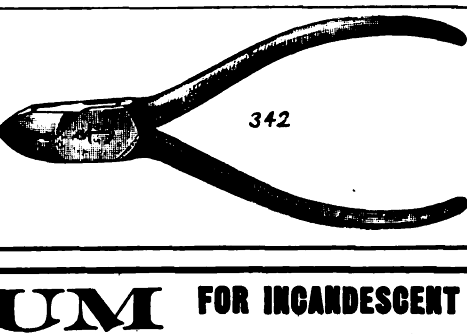

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AUTOMATIC ELECTRIC COMPANY, Chicago, Ill., extends a cordial invitation to delegates to the Interstate Independent Telephone Association, which meets in Chicago, December 9, to visit its new factory at the corner of Morgan and Van Buren Streets. Special arrangements have been made to receive convention visitors, and to put them in possession of complete information regarding the automatic telephone switchboard system manufactured by this company. A switchboard of 1,000 lines capacity will be exhibited at the factory in operation.

LINK BELT ENGINEERING COMPANY, Philadelphia, Pa., reports an enormous business in the sale of Renold silent chains. Recent sales included 9 line shaft drives from motors in the new works of the Patton Paint Company, Newark, N. J.; 8 drives from motors to line shafts and elevators in the new model plant which the Crompton & Knowles Loom Works are erecting in Philadelphia; and eight 60 horse-power drives for induced-draft blowers in the new Waterside Station of the New York Edison Company. There are now sixty-one Renold Silent Chains in use in the new building of R. H. Macy & Company, varying in capacity from one to ninety horse-power.

CLING-SURFACE MANUFACTURING COMPANY, Buffalo, N. Y., continues to receive flattering testimonials to the merits of its well-known belt dressing. Among recent letters of this kind were the following:

"One of my belts was in bad shape *from oil.* Cling-Surface has just commenced to drive the oil through the belt and it has made the belt very pliable. J. W. Irvine, Electrician,
"Windsor Hotel, Gallatin, Mo."

"Cling-Surface has been very satisfactory. Our belts were soaked full of oil and very dirty, but we believe Cling-Surface is going to put them in excellent shape.
"Las Animas Light, Power & Mfg. Co.,
Trinidad, Col."

"An old belt so thoroughly soaked with oil as to be useless was treated with Cling-Surface and in a short time was doing excellent work.
"W. H. Wakeman, Engineer,
New Haven. Conn."

THE ROONEY-WESTBURY ELECTRIC LAMP COMPANY, New York, has been incorporated to manufacture miniature incandescent lamps and accessories. These lamps may be divided into three classes: Lamps designed solely for decorative work; lamps used in telephone switchboards, visual signal annunciator systems, dental and surgical instruments, etc., and special lamps, such as the candelabra type, the varied kinds of battery lamps used in portable novelties, clock lights, etc. There are at the present time upwards of 7,000 forms of miniature lamps and this number is continually being added to. The Rooney-Westbury Company has a number of novelties in this line of work.

One is a double-filament battery lamp so arranged that it can be burned with both filaments at once or one at a time. Another is a special form of miniature reflector lamp with a silvered bull's eye. Several ingenious novelties in automobile lamps with reflectors are also included in the list.

THE ELECTRIC STORAGE BATTERY COMPANY recently closed a contract with the Baltimore & Ohio Railroad Company for the installation of a second battery of "Chloride" accumulators at the Mt. Royal entrance of the Baltimore & Ohio tunnel, Baltimore. The first battery was installed in November, 1900, in a building which was designed for the installation of two batteries; and the second battery is put in as the result of the successful service which has been obtained from the original plant. The Baltimore & Ohio Railroad Company has completed its plans for the electric haulage through the tunnel of both its freight and passenger trains, and for this purpose has contracted for two electric locomotives, each of approximately double the capacity of the ones now in service. The demand which will be occasioned by this increased service necessitated a corresponding increase in the power equipment, and it was decided that the best way of obtaining this was by the installation of another battery. Before the first battery was installed, the load required at times the operation of three 500-kw. generators. On the installation of the original battery this number was reduced to one, and it is estimated that even with the increased service of the heavier locomotives and the more frequent trips, the larger capacity in battery output will still allow the entire work to be done by the one generator.

THE NEW LUNKENHEIMER FACTORY, at Fairmount, Cincinnati, which was opened October 25, is a mammoth establishment. The buildings, of which there are five, are all of pressed brick and steel construction of modern type. They occupy about three acres of ground and have ample railroad switching facilities; three acres additional ground provide for future extension of the business.

The main building, 130 x 180 feet, is of the gallery style of construction; it is three stories high and built so that three more stories can be added without interfering with the operation of the shops. A novel feature in the main building is the heating system. The hot air travels through the fourteen large hollow columns which support the floors around the area in the center of the building; these columns have openings on each floor to distribute the air; and the bases of the columns are connected with a huge fan by means of tunnels under the basement floor. By this construction the usual galvanized iron air pipes are rendered unnecessary. The general distribution of power throughout the buildings is thoroughly modern. The source of energy is a 300-h.p. compound engine which drives a 240-kw., three-phase, 220-volt General Electric alternator. General Electric and Westinghouse induction motors drive the various lines of shafting through Renold silent chain gearing. Nernst lamps furnish the artificial illumination for the offices and shops. The office building is a three-story pressed brick structure, 50 x 80 feet; the second floor is occupied by the draughting and engineering departments, and the third by the advertising department, laboratory and photograph gallery.

The business was founded in 1862 by the late Frederick Lunkenheimer and has grown to large proportions, now employing over 700 men. With increased facilities the company expects to extend its lines and take up many new engineering specialties.

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Reducing Valves
ARE THE WORLD'S STANDARD VALVES
For automatically reducing and absolutely maintaining an even steam or air pressure.
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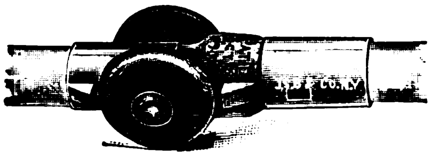
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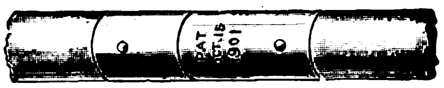
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This book contains just what its title indicates,—157 plain questions, plainly answered concerning steam engineering.—192 Pages—Price 50 Cents.

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1—36 x 72 Wheelock engine.
1—20 x 48 Corliss.
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1—15½ x 16 N. Y. Safety Power.
1—12 and 20 x 12 comp. Westinghouse.

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1—16 and 27 x 16 comp. Westinghouse.
2—13 x 12 Erie Ball.
2—15½ x 15 Armington & Sims.
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2—175-hp Sterling boilers.
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1—72-in. x 17 ft. Return Tubular.
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1—5-H.P. Onondaga, multipolar	110.00
1—7½-H.P. Eddy, A1 condition	125.00
1—15-H.P. Bound Brook Eng. Co., good as new	$230.00
1—25-H.P. G. E. Multipolar	325.00

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1—¼-H.P. Detroit	$20.00
1—½-H.P. Elbridge, new, 110 volts	26.00
1—½-H.P. Elbridge, new, 5 volts	26.00
1—7½-H.P. Hobart, second-hand, 110 volts	165.00
1—10-H.P. G. E., slow speed, D.C., A1 con.	235.00
1—30-H.P. E. & E., second-hand, 110 volts	325.00

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1—60-Lt. second-hand, T. H. 1100, 104, 52 trans.	$25.00
1—40-Lt. second-hand, T.H. 1100, 104, 52 trans.	18.00

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1—8-Lt. Elbridge, new 110 volts	$25.00
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1—60-Lt. Onondaga, bipolar 110 volts	90.00
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1—150-Lt. G. E. slow speed 110 volt, speed 800	240.00
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1—150-Lt. Climax, new commutator, A1 condition	160.00
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1—50-amp. Elbridge, new 6 volts	30.00
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1—13x23x17 McIntosh & Seymour.
1—8x14½x10½ McIntosh & Seymour.
2—15x24x18 Armington & Sims.
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2—120-K.W. Stanley, 125 cycle, 2 phase.
2—60-K.W. Stanley 60 cycle, 2 phase.
2—60-K.W. Stanley 125 cycle, 2 phase.
4—60-K.W. G. E. 125 cycle, single phase.
2—60-K.W. Westinghouse, 125 cycle.
2—30-K.W. Westinghouse 125 cycle, single phase.

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